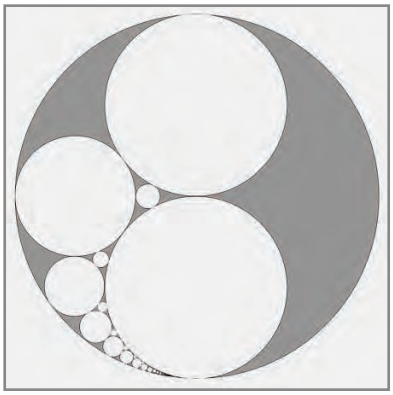
# Modern Sangaku



**By Jean Constant**

**The Math-Art series ™**

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# About the Art

The Japanese Sangaku tradition explores and highlights the strength and consistency of fundamental geometry. In the world of English mathematician John Rigby, “Sangaku, were hand-carved wooden blocks, containing collections of problems and accompanied by beautiful coloured figures.”

Sangaku problems are found to be very similar to Pythagorean and Euclidean geometry in areas and volumes. They were very popular in Japan during the Edo period (1603-1867). Sadly, by the 20th century, the Sangaku tradition was all but forgotten, and today fewer than a thousand tablets have survived abandonment or destruction

Today, thanks to the efforts of scholars and mathematicians such as Fukagawa, Pedoe, Okumura, Rothman, Bogomolny, Birrane, Boas, Rigby, Nomura, Unger, and many others, the Sangaku tradition is experiencing a rebirth and a growing public interest as mathematicians worldwide revisit the original problems, even create new challenges.

Coming from a visual arts background, I was first attracted to this form of expression because of its unique combination of colorful squares, triangles, and circles,

set in playful motion and challenging the viewer to solve a mathematical problem. It led me to revisit the Sangaku pictorial tradition and ask myself how a modern eye could use a timeless tradition and bring into our technological environment the same elements of intellectual, spiritual, and aesthetic satisfaction while honoring, if not the skill, then the intent of its original authors.

The following is an extended series of variations on Sangaku problems I explored over many years in various graphics editors. It is a tribute to mathematicians and artists alike, then and now, who “brought mathematics and geometry out of the classroom and into our culture in such a poetic way.

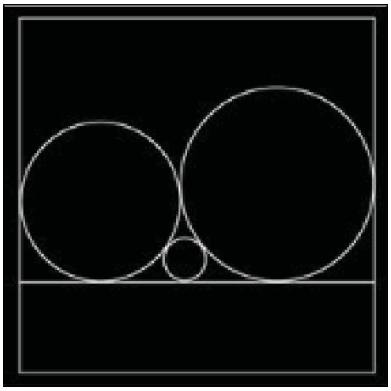
Jean Constant

**Update (02-2026)**

Recently, a few readers have asked if I used AI to create these illustrations.

This project took place before ubiquitous AI(s) infiltrated every area of our working environment. Even today, I am not sure I would want to use an AI for such projects, having noted that its main weakness is its self-correcting algorithm, which often relies on the majority of available opinions rather than on precise, accurate, and objective scientific descriptions.

# Sangaku Gallery 1



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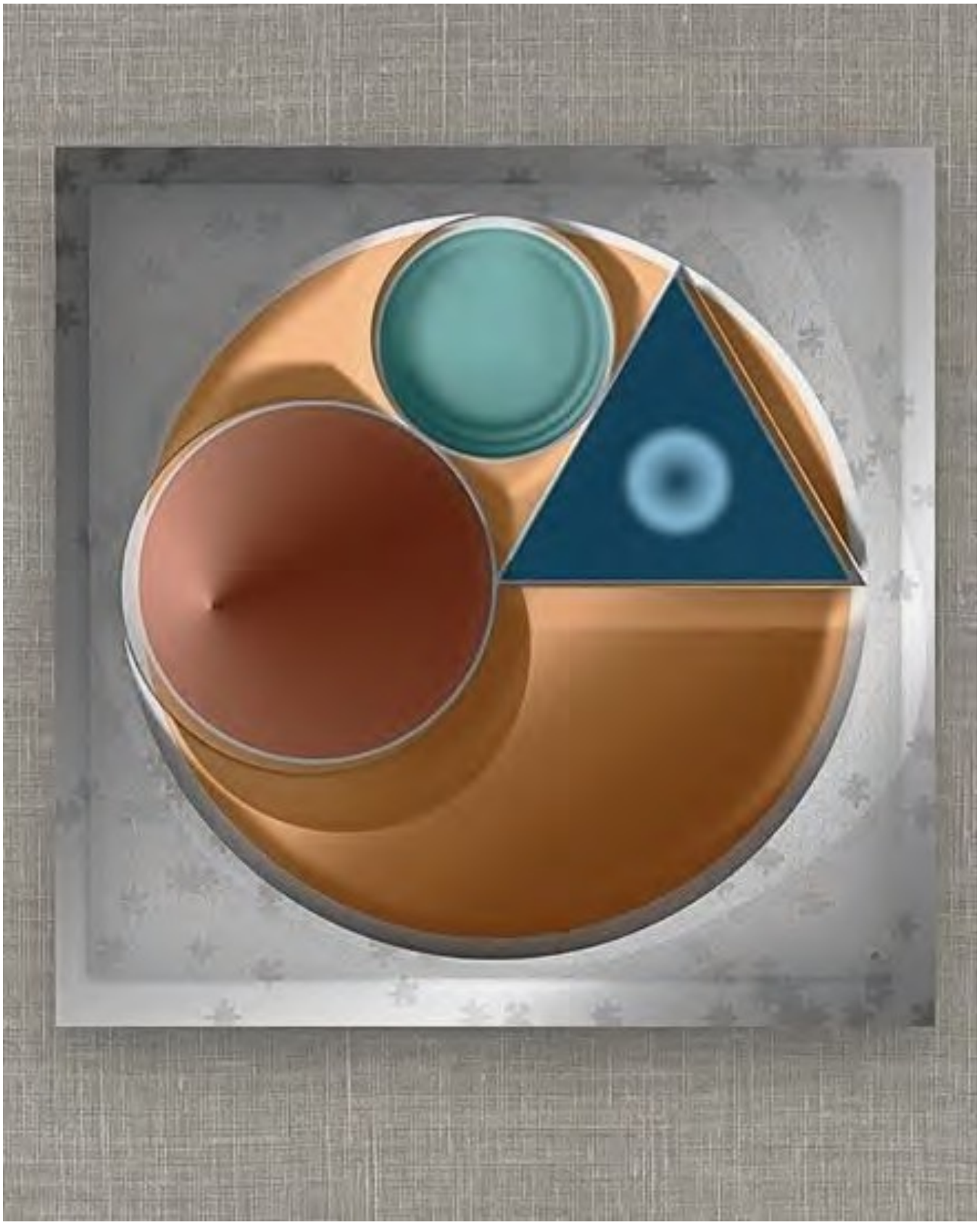

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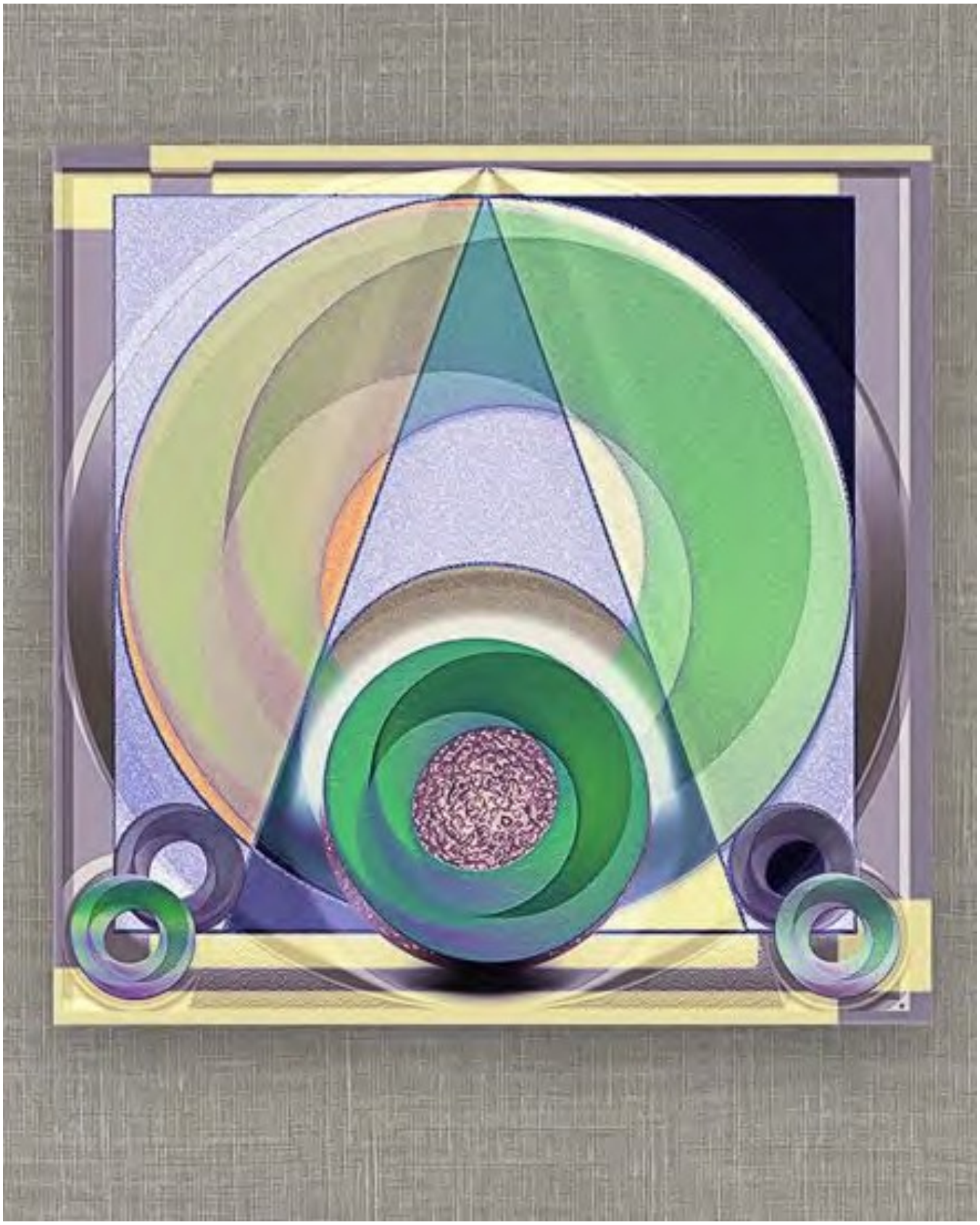

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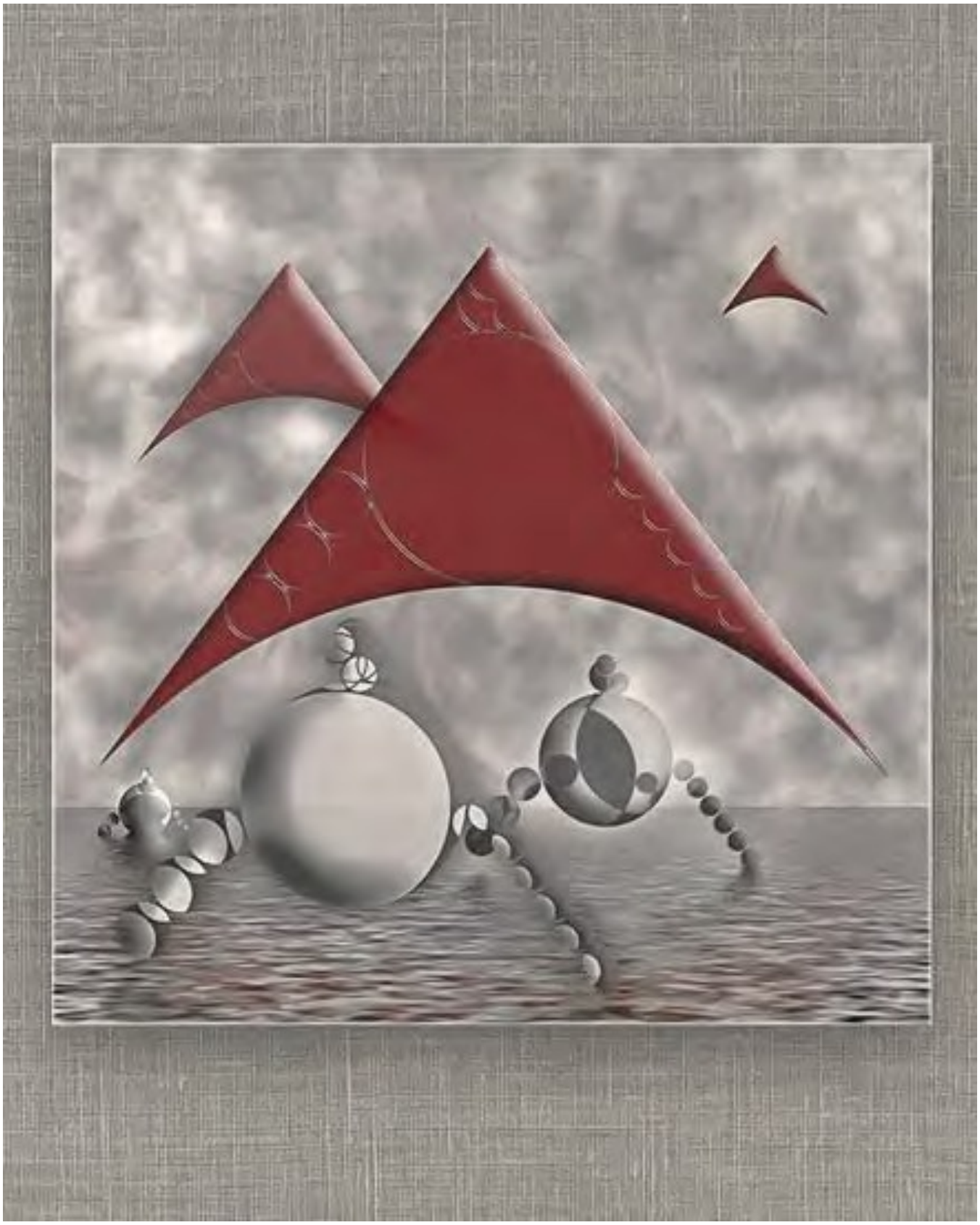

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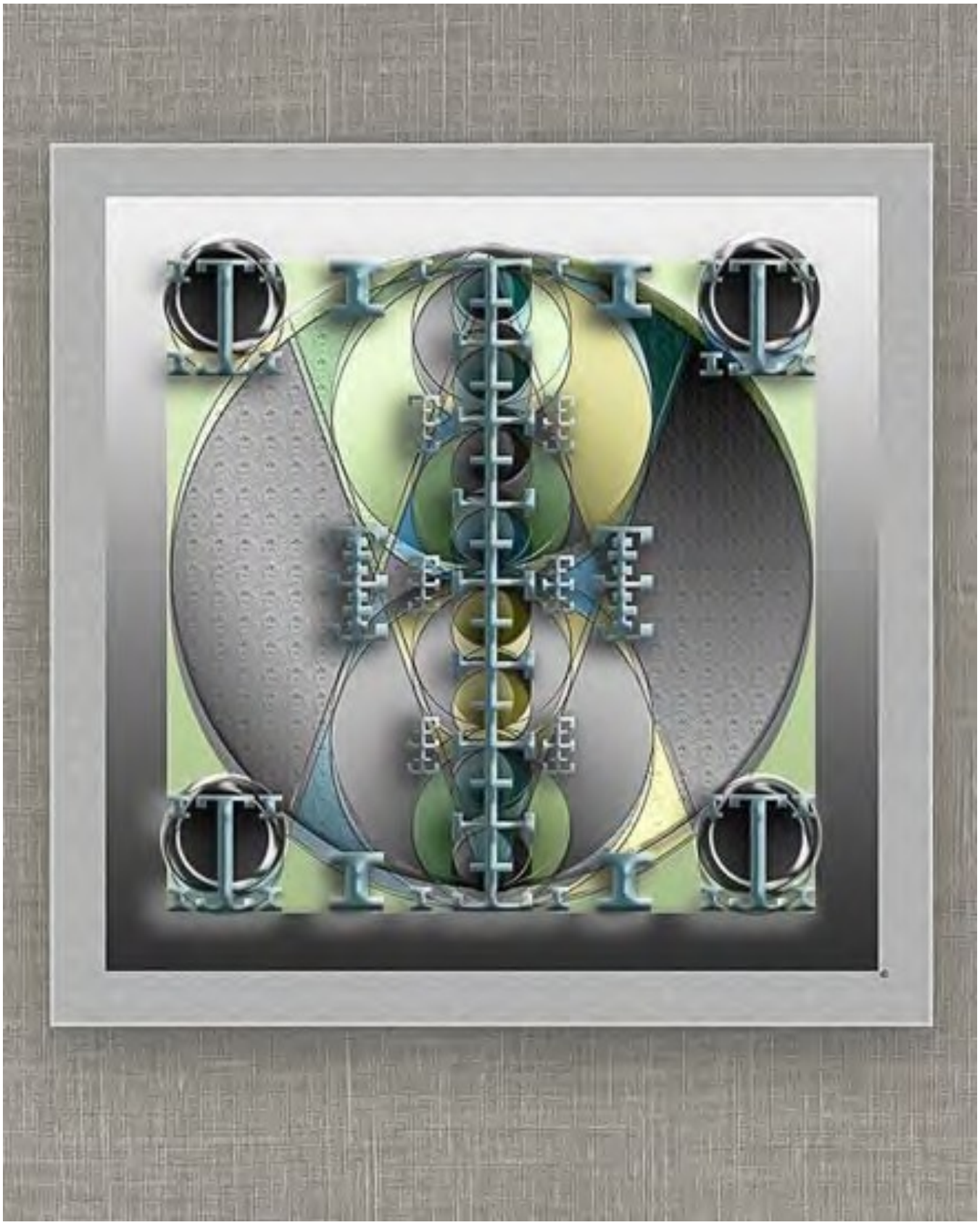

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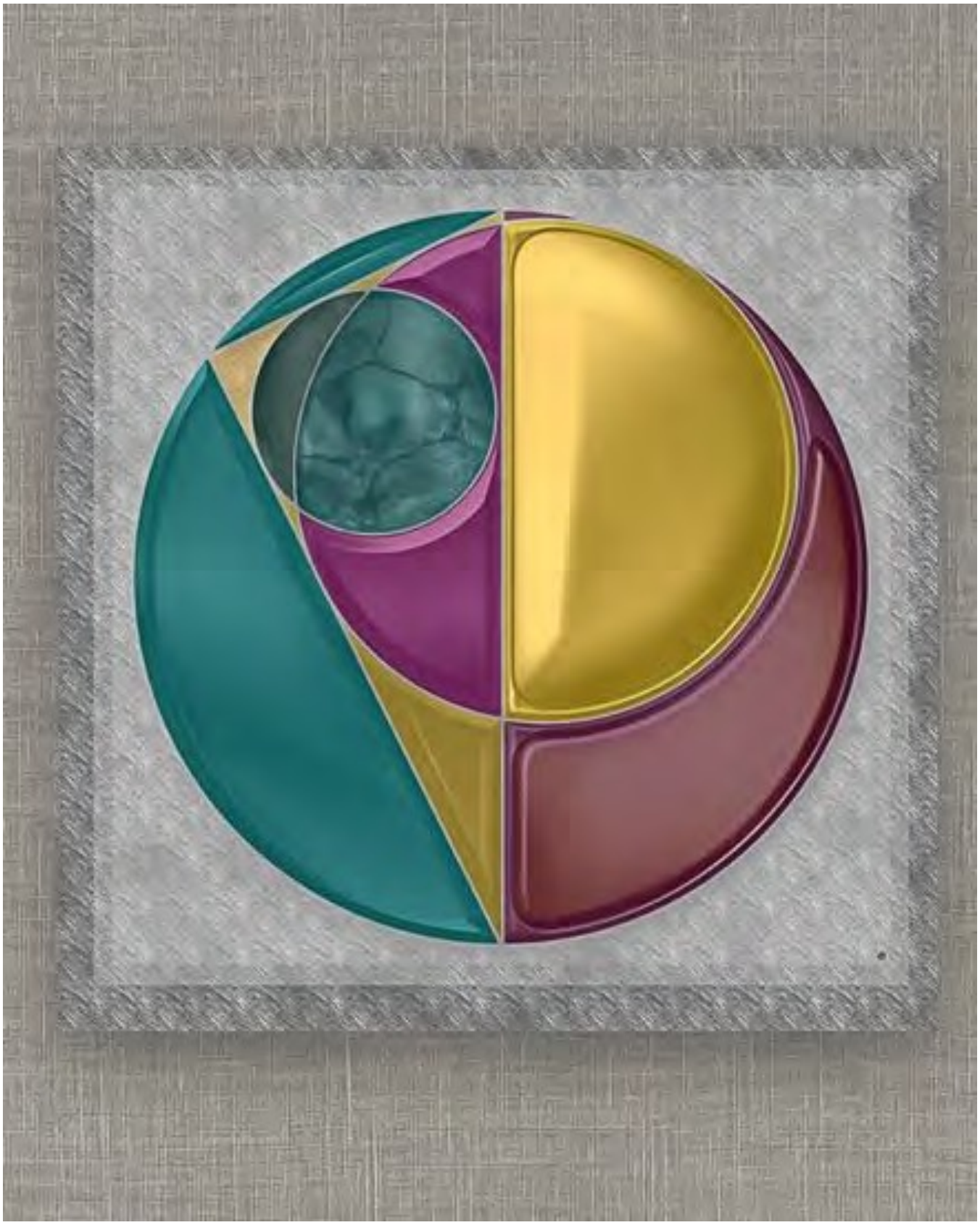

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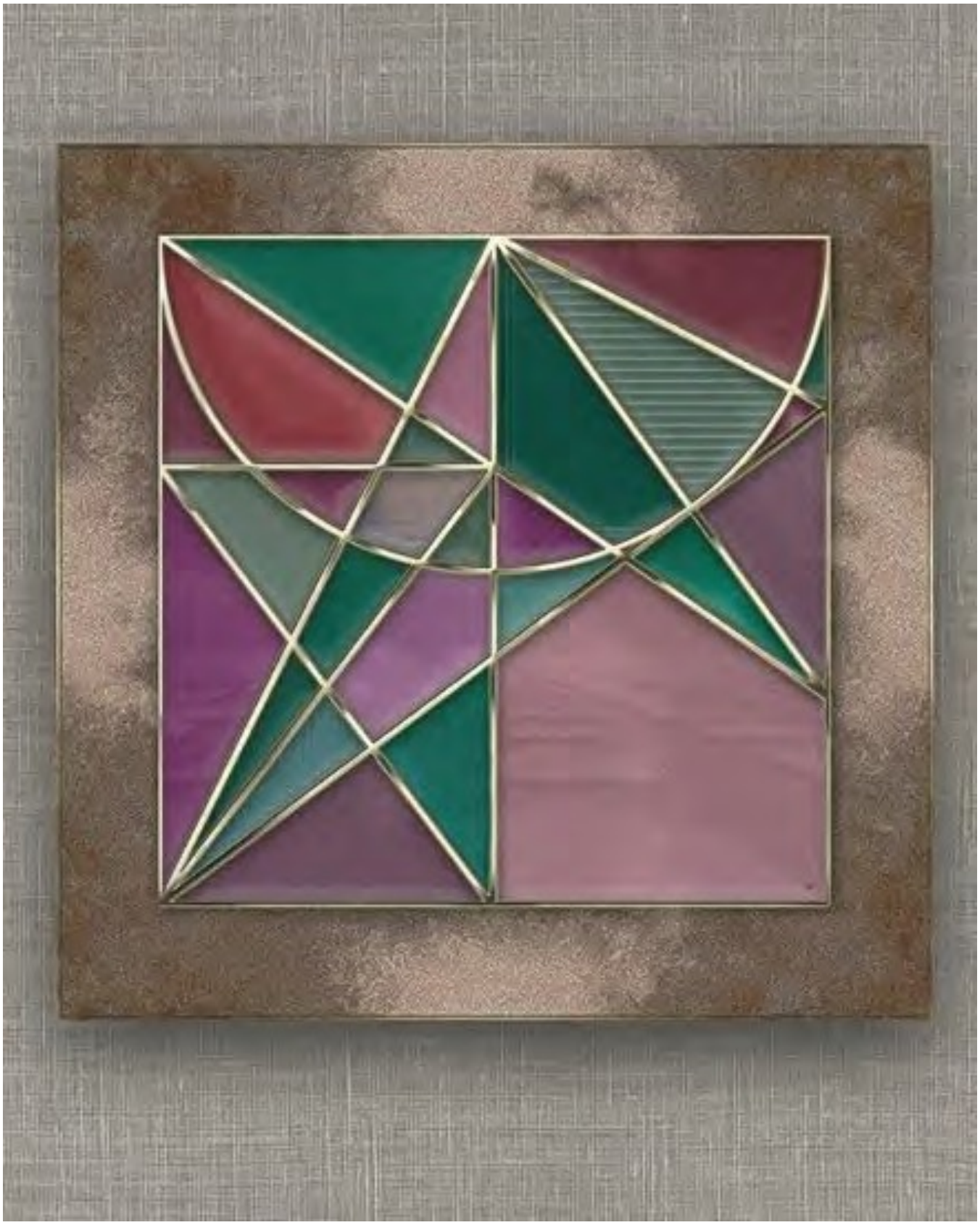

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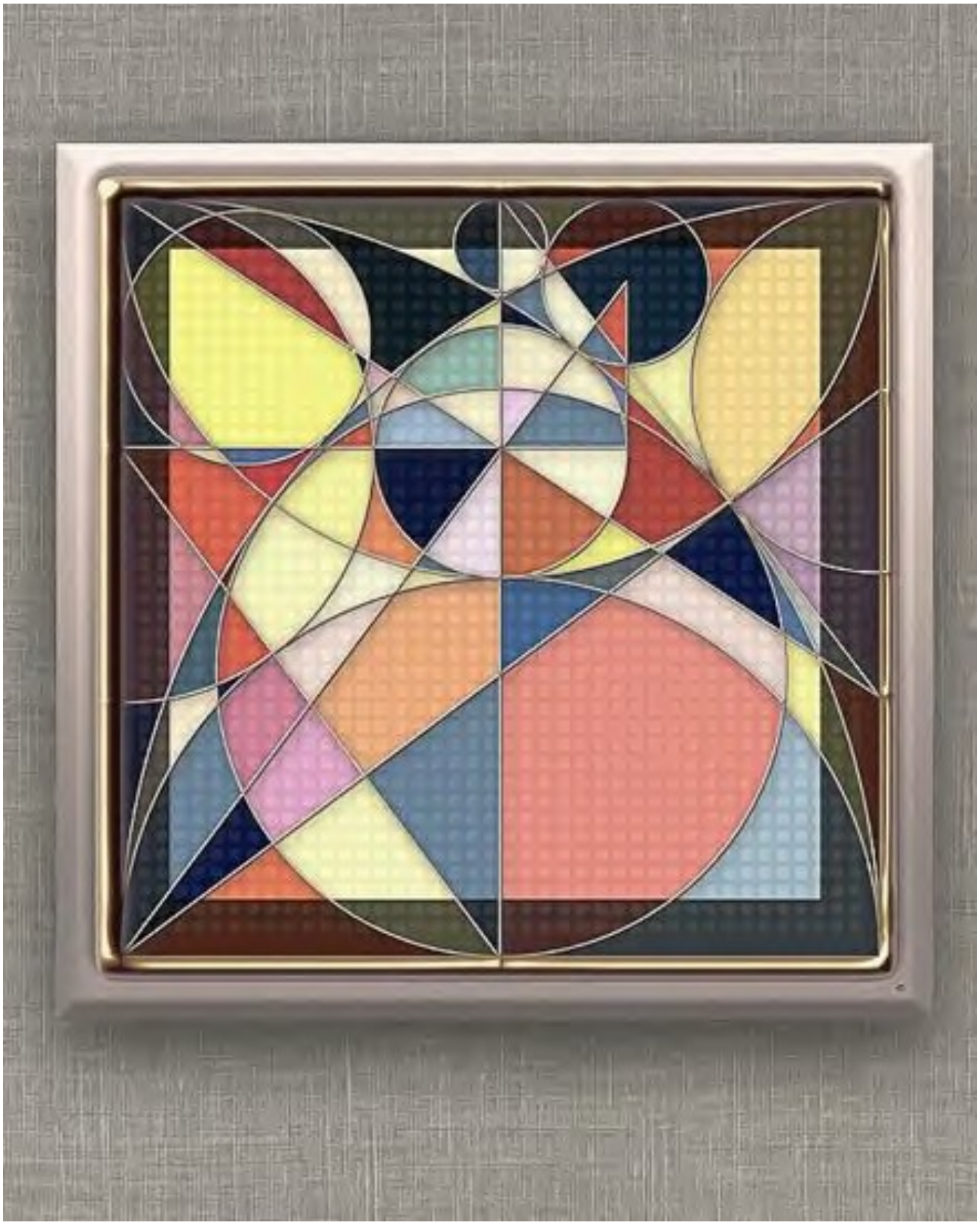

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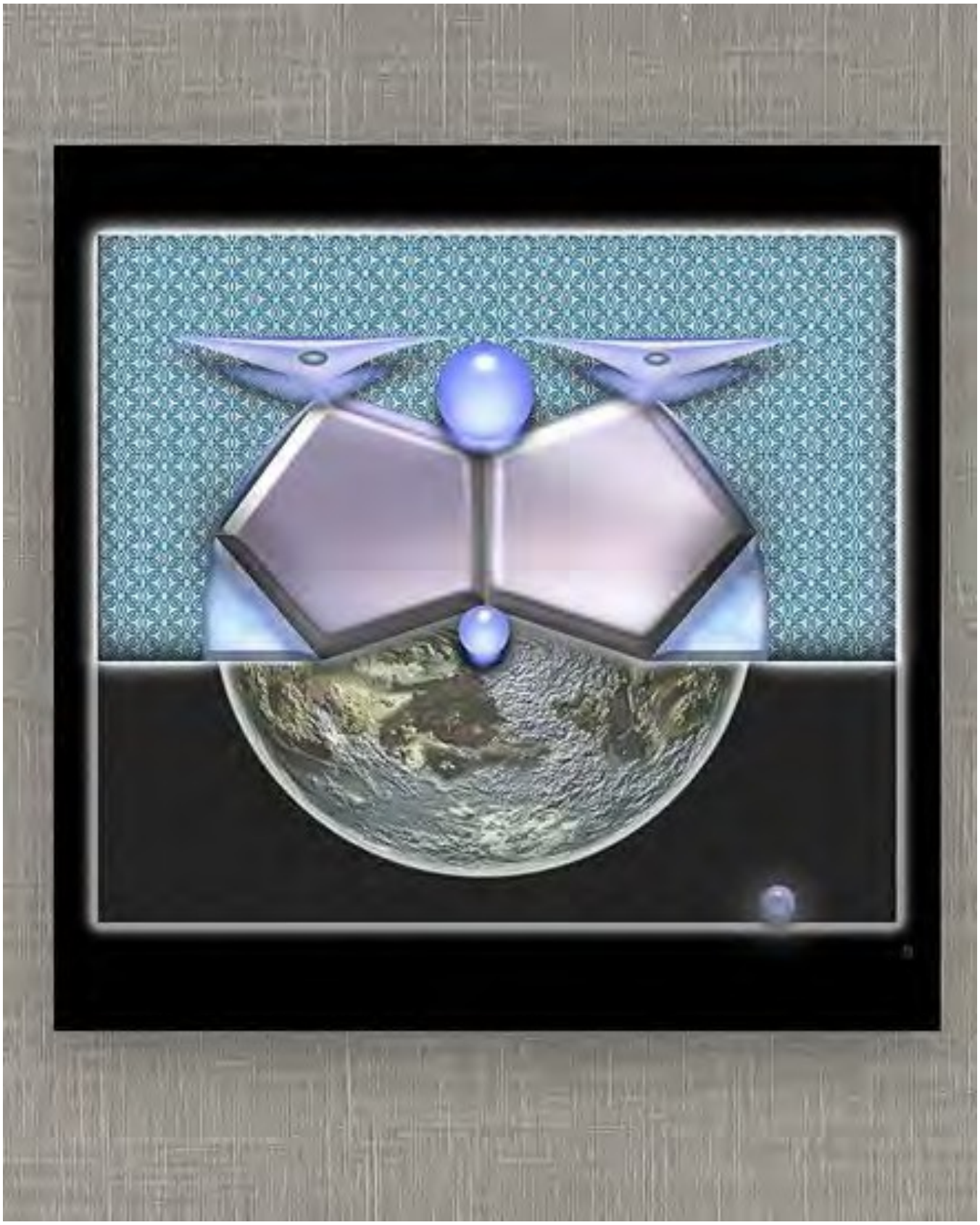

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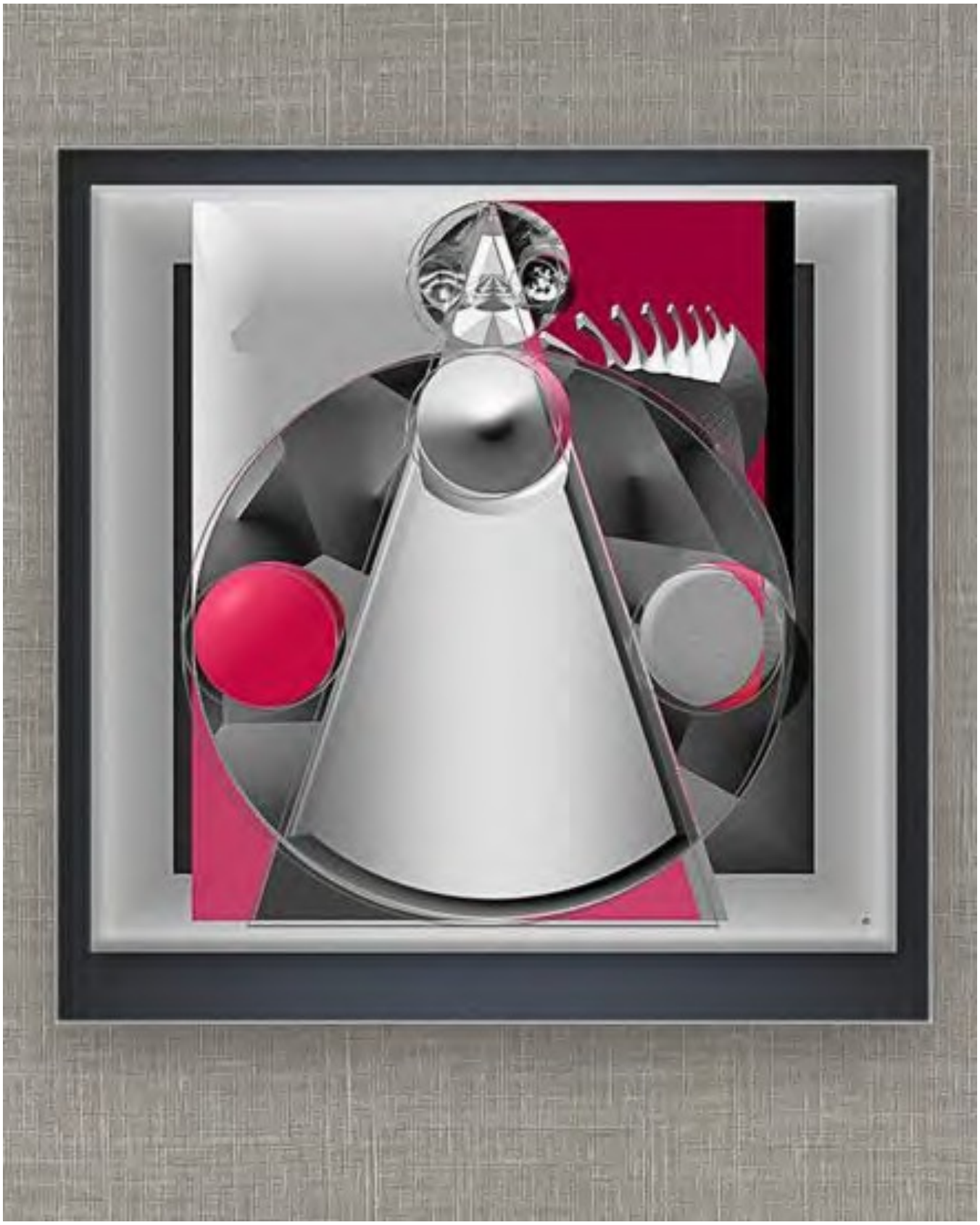

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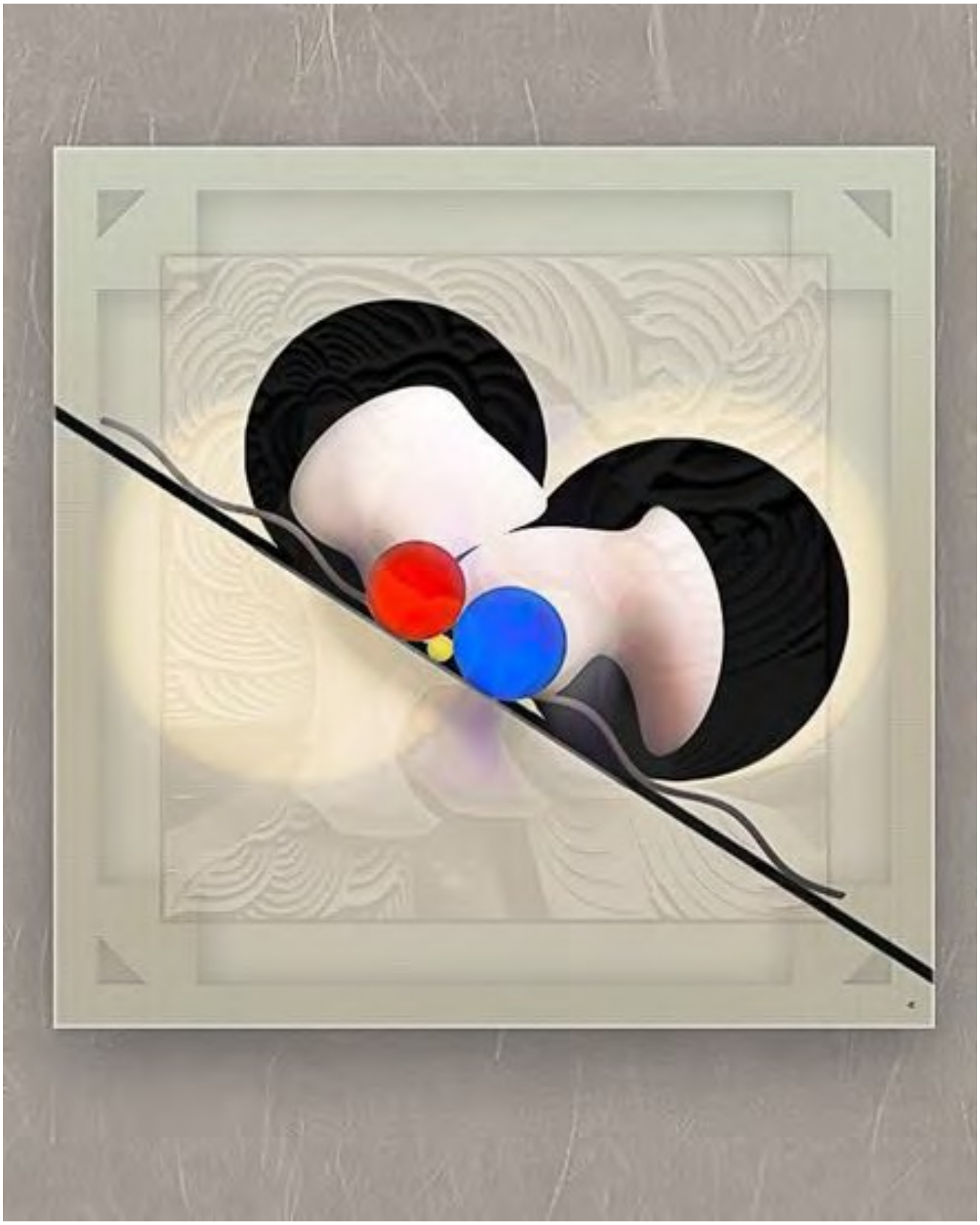
# Sangaku Gallery II



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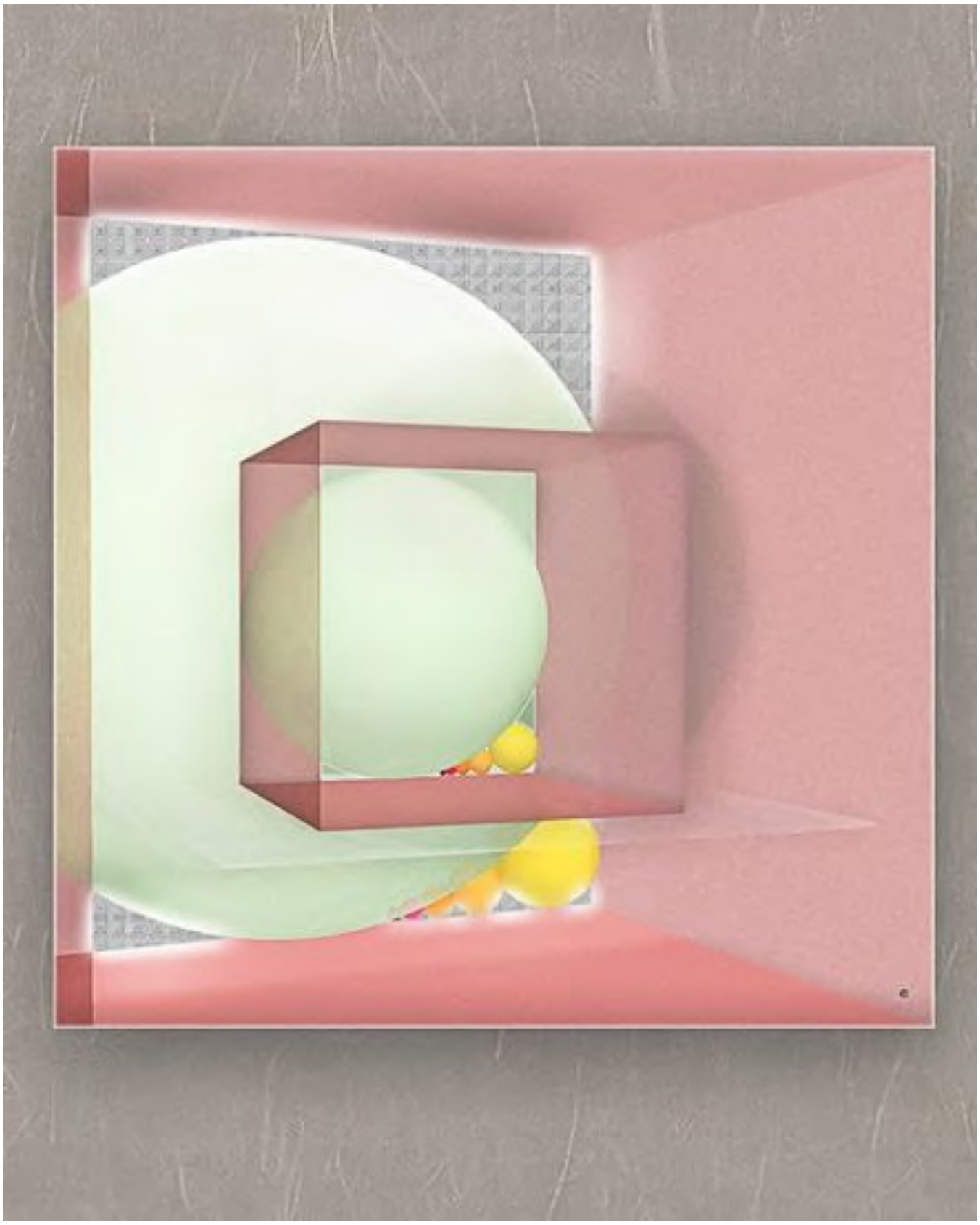

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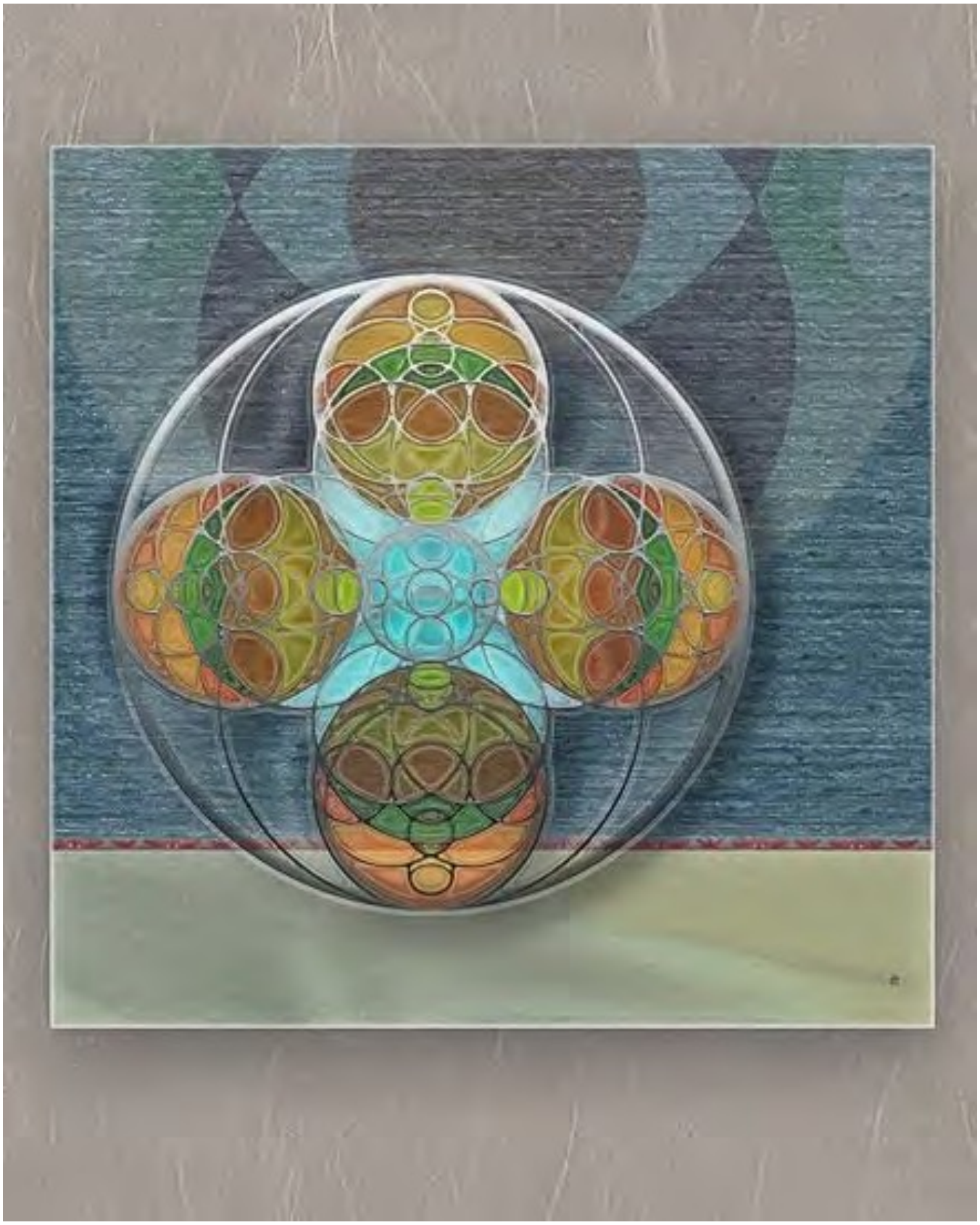

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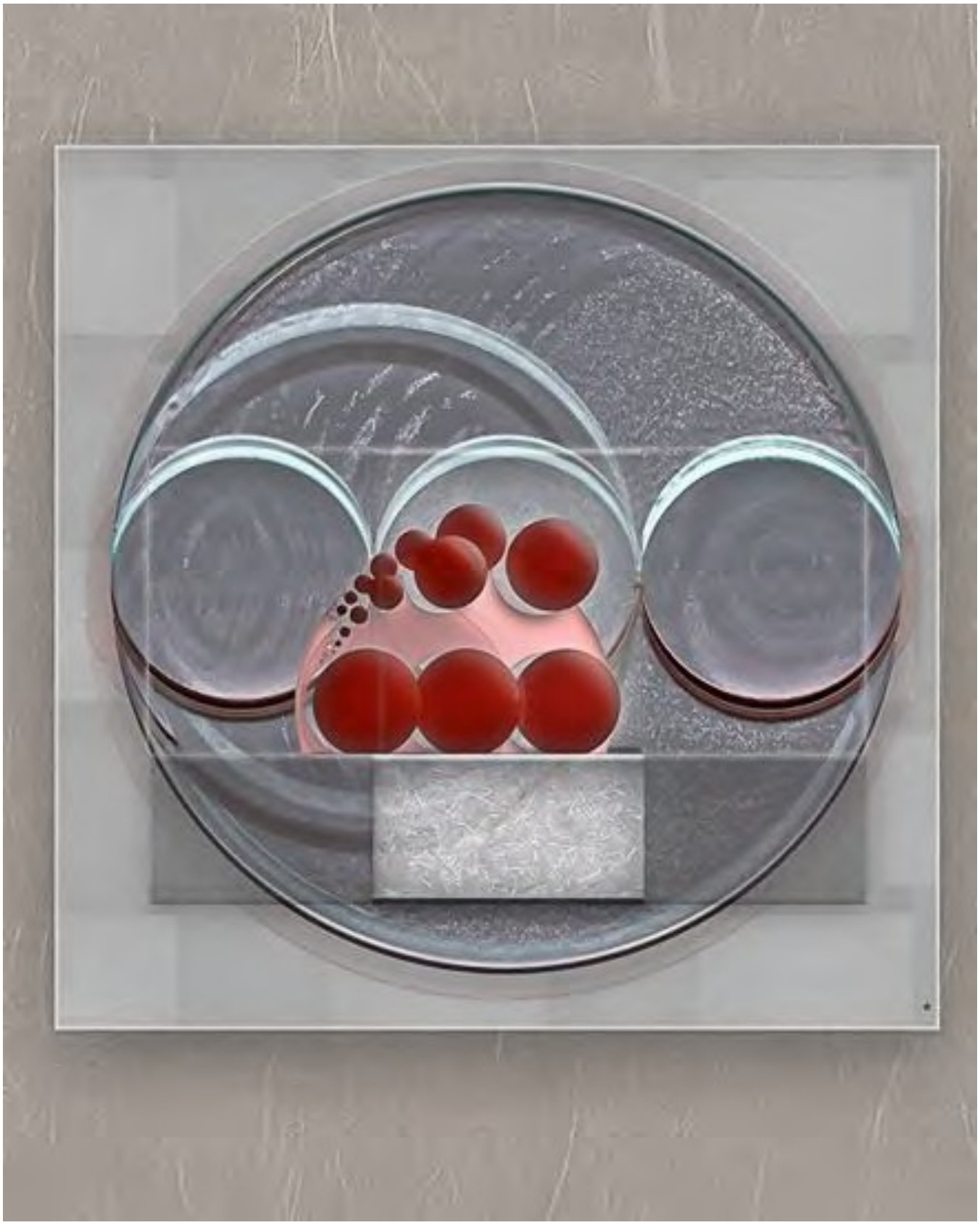

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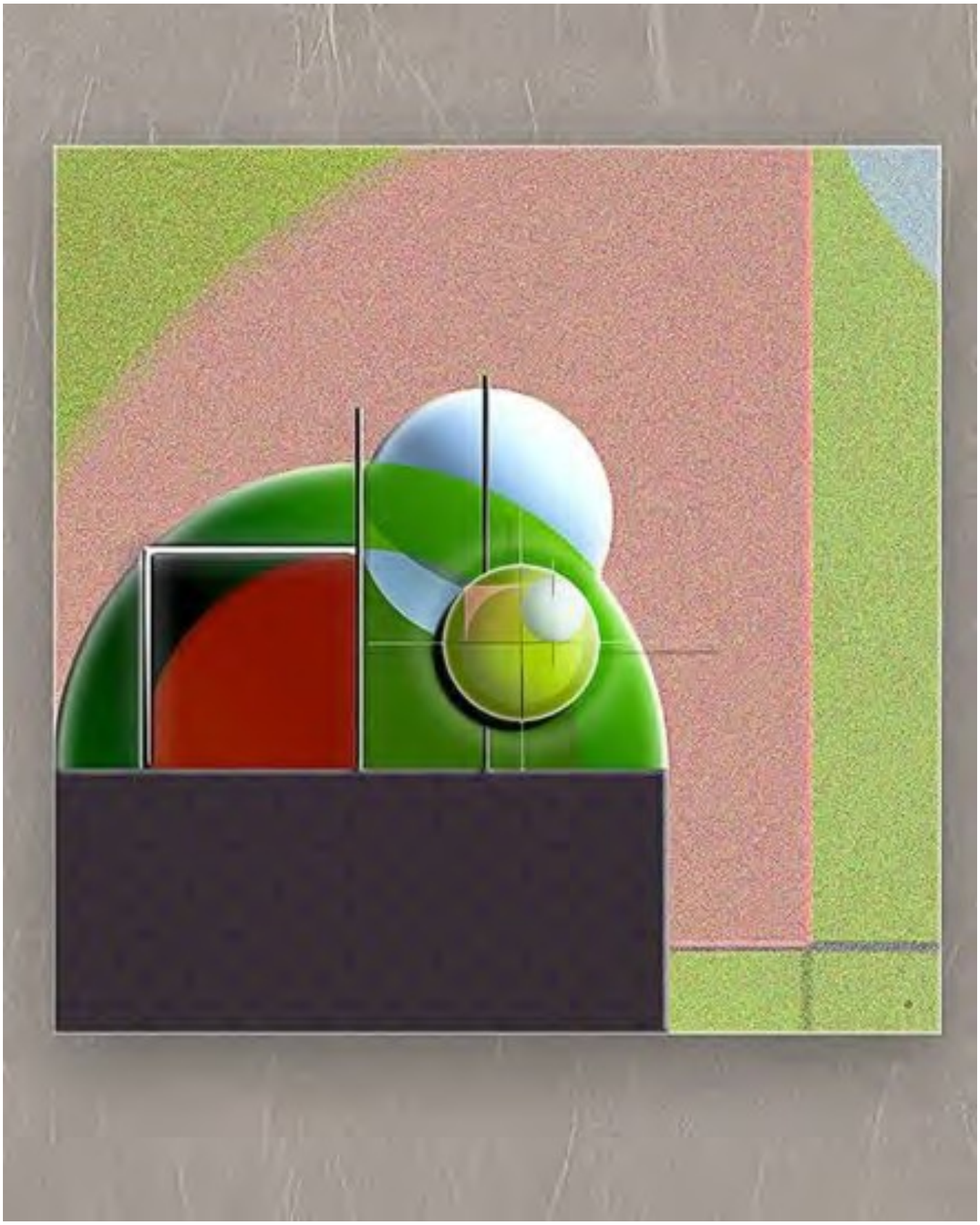

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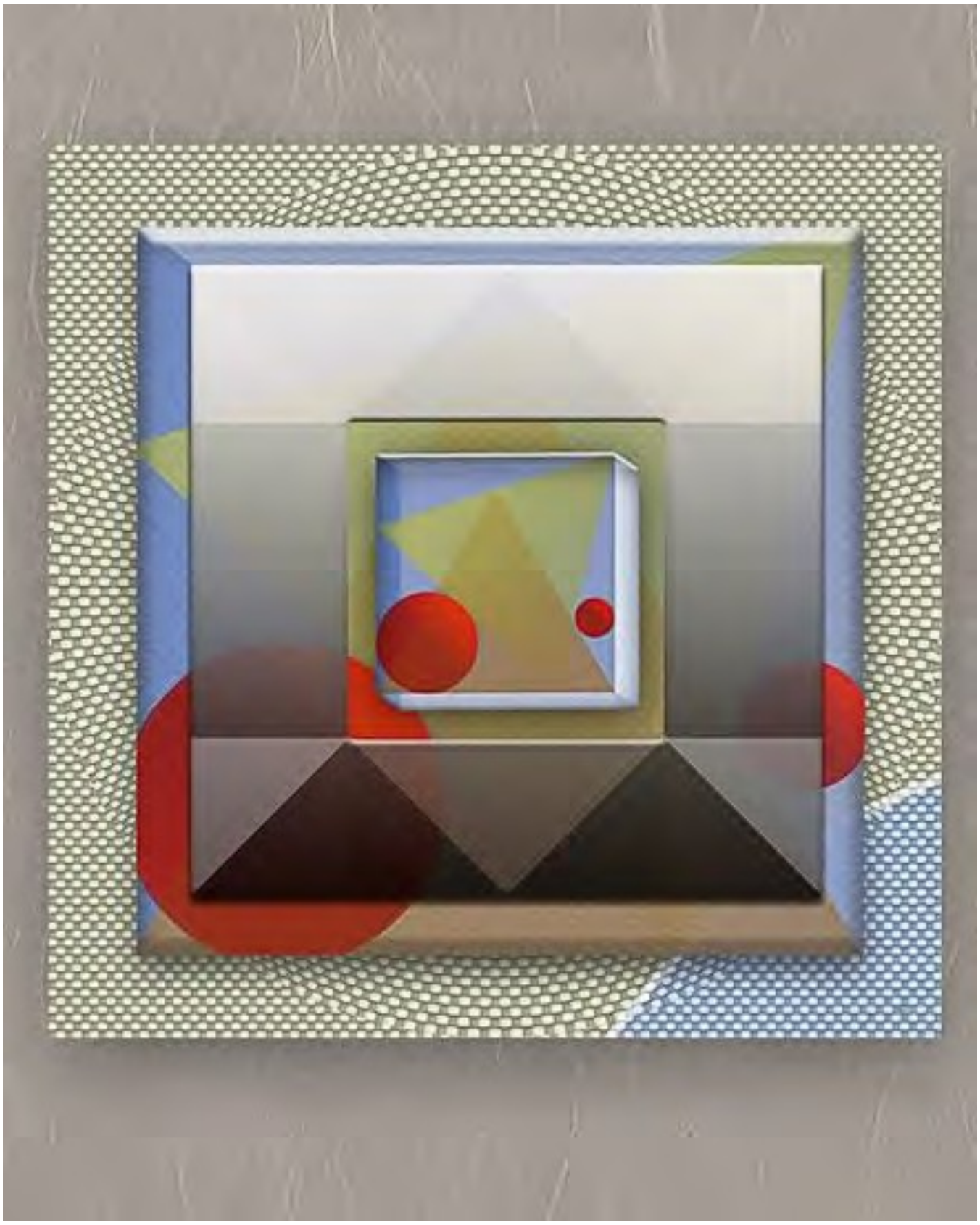

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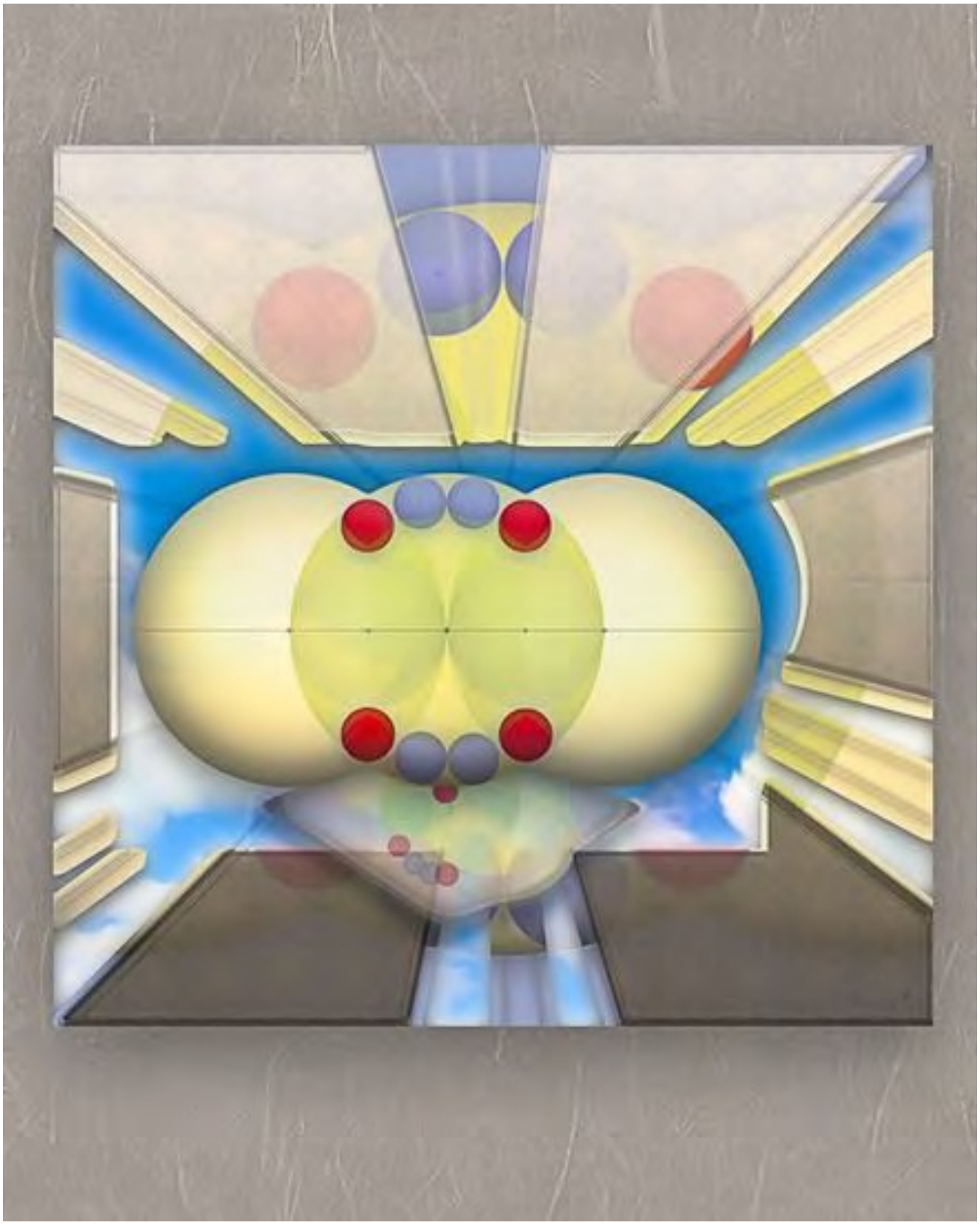

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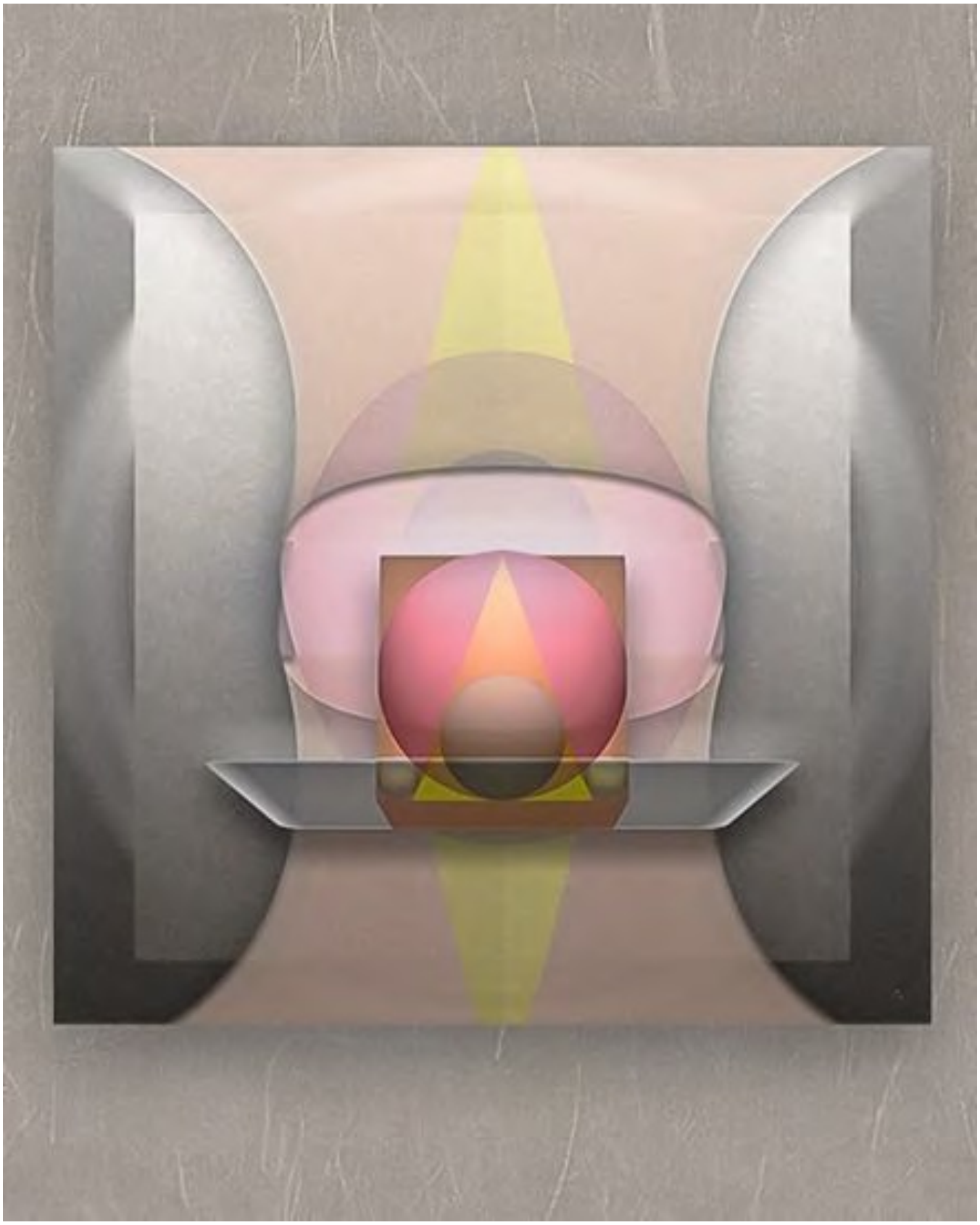

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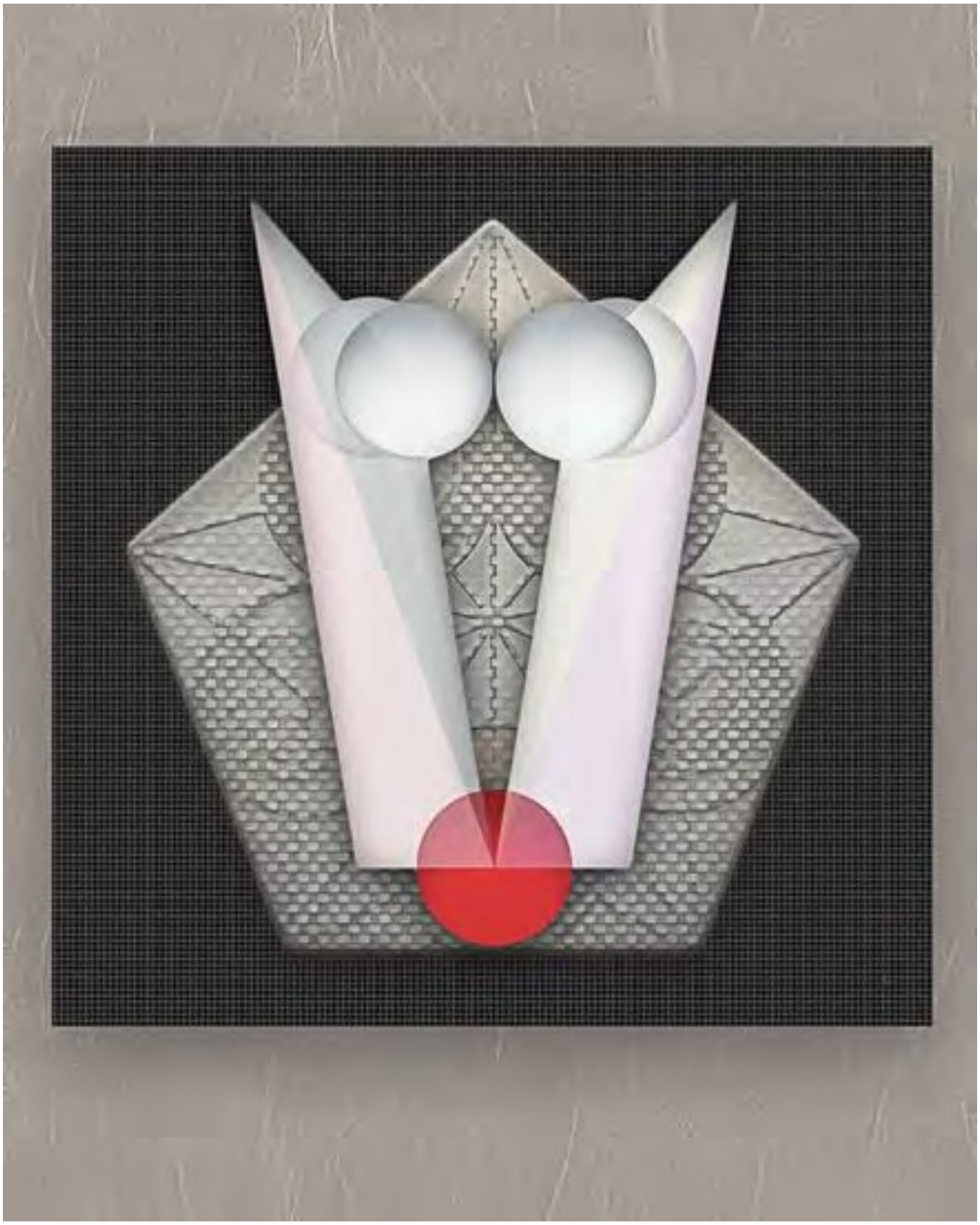

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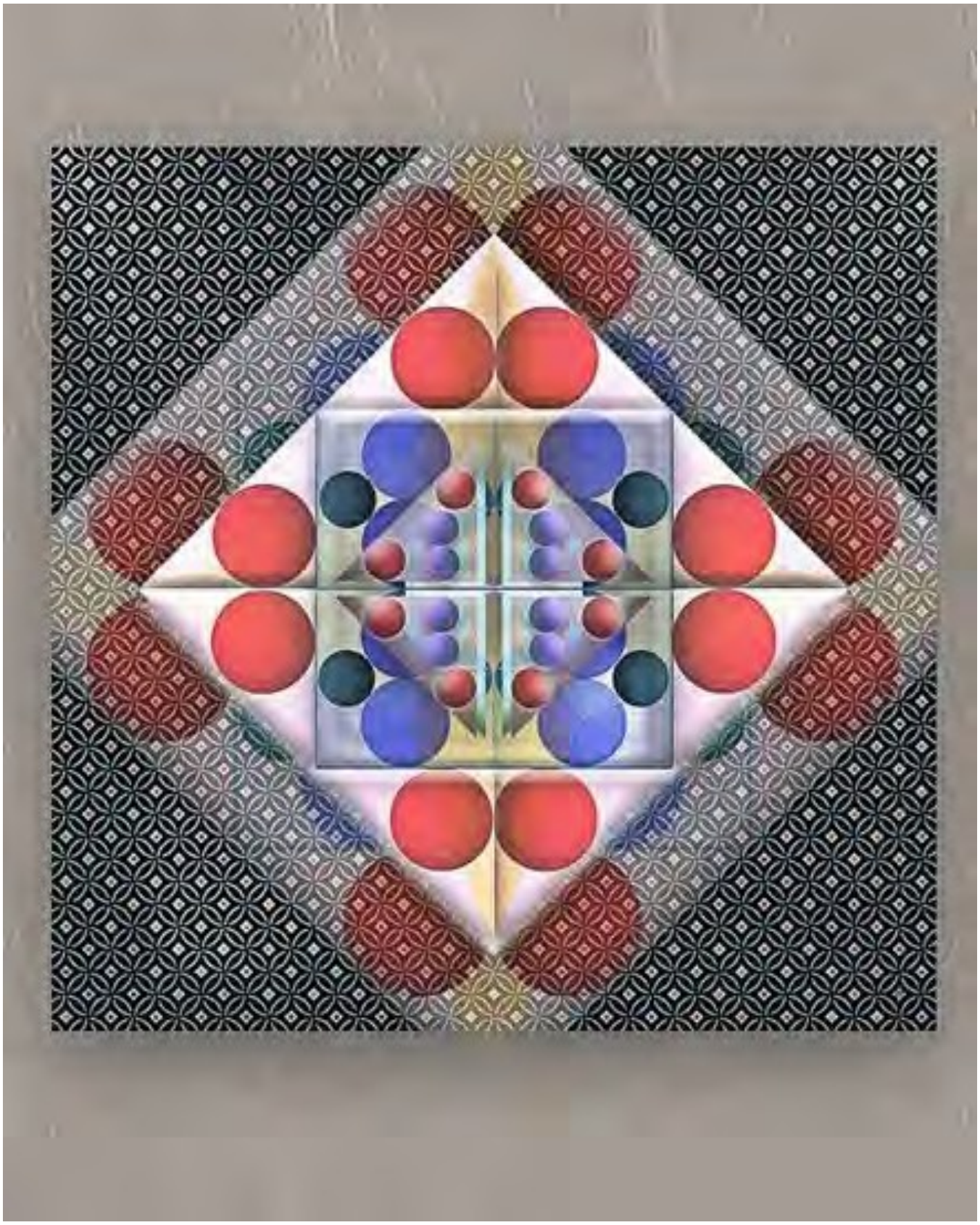

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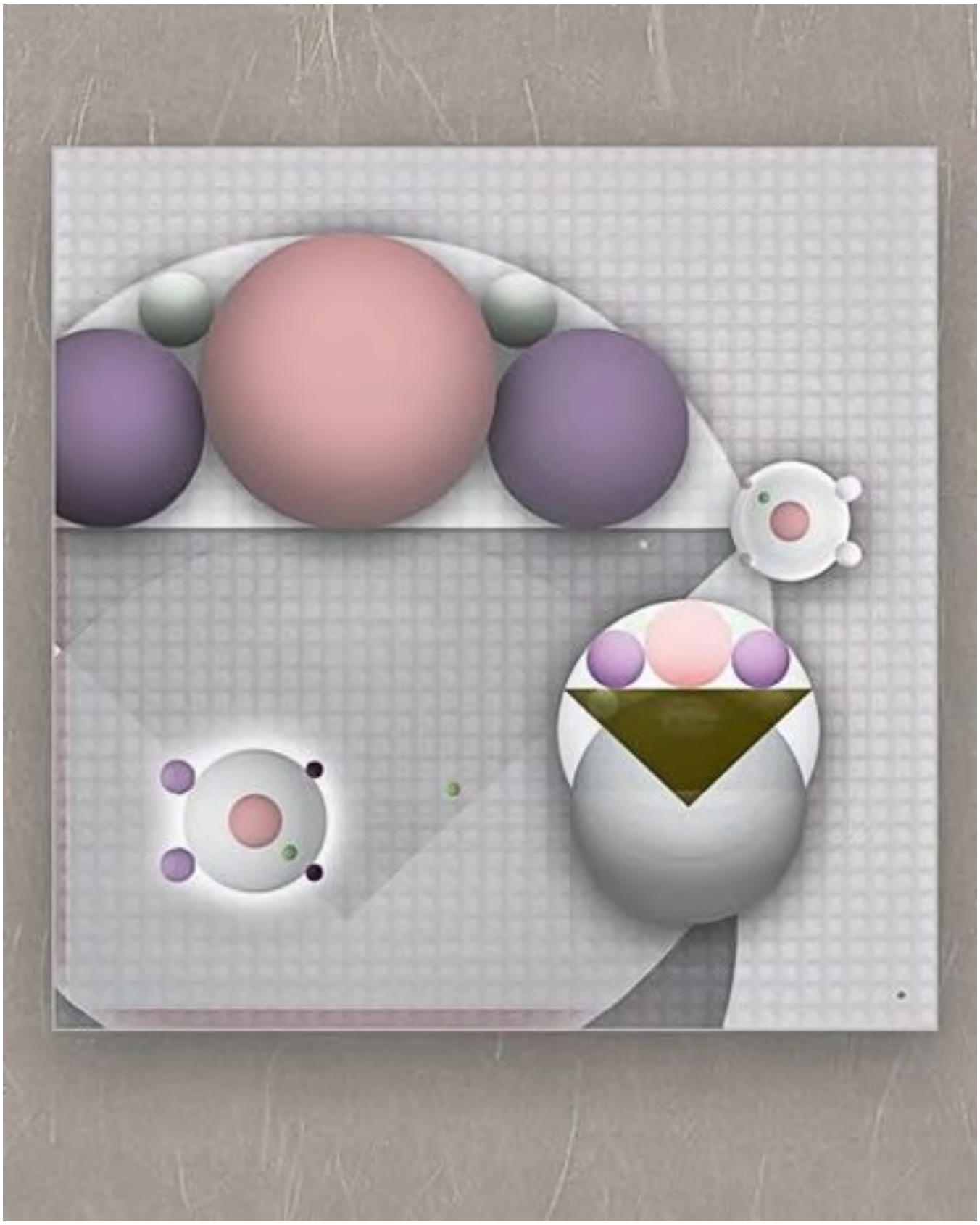

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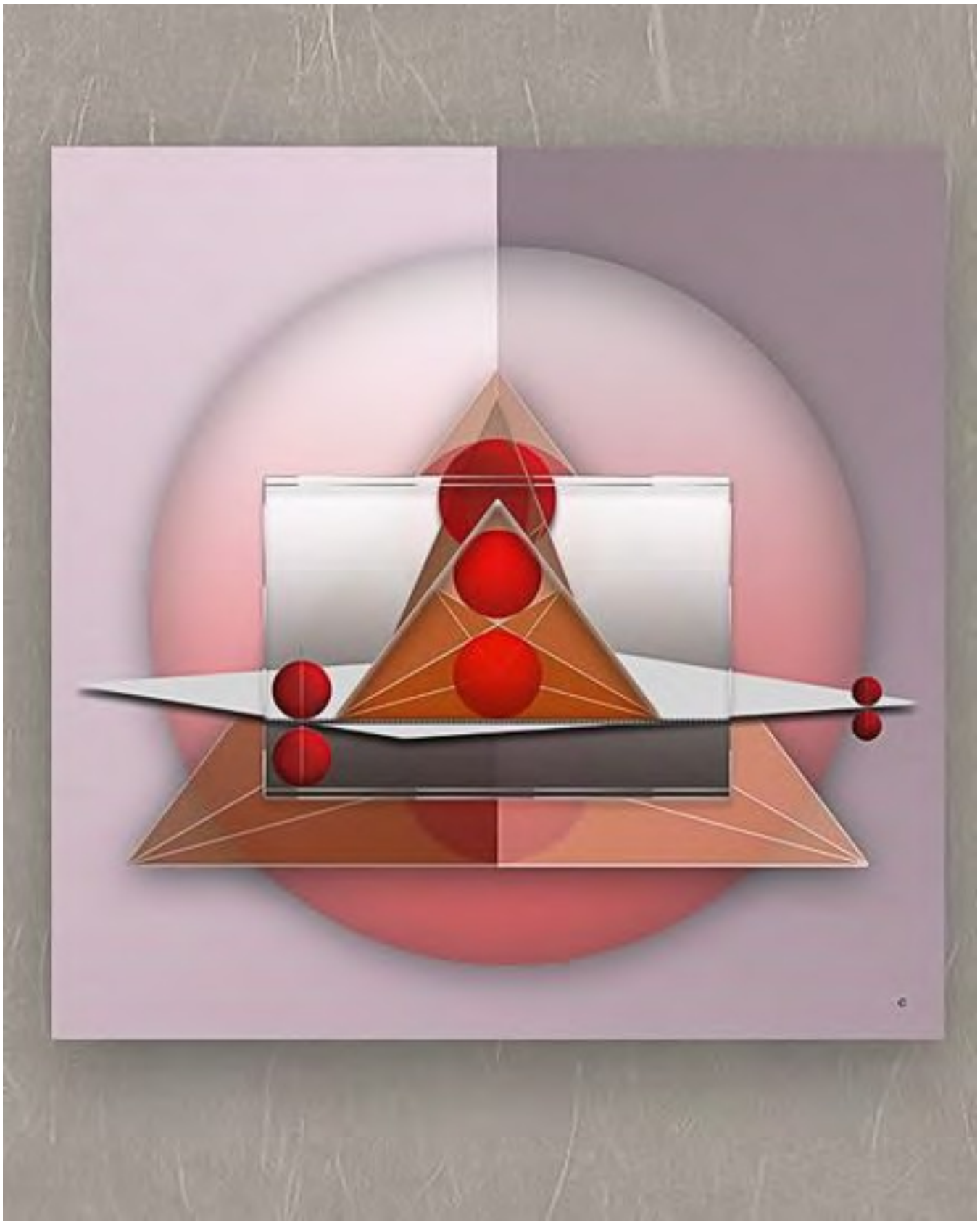

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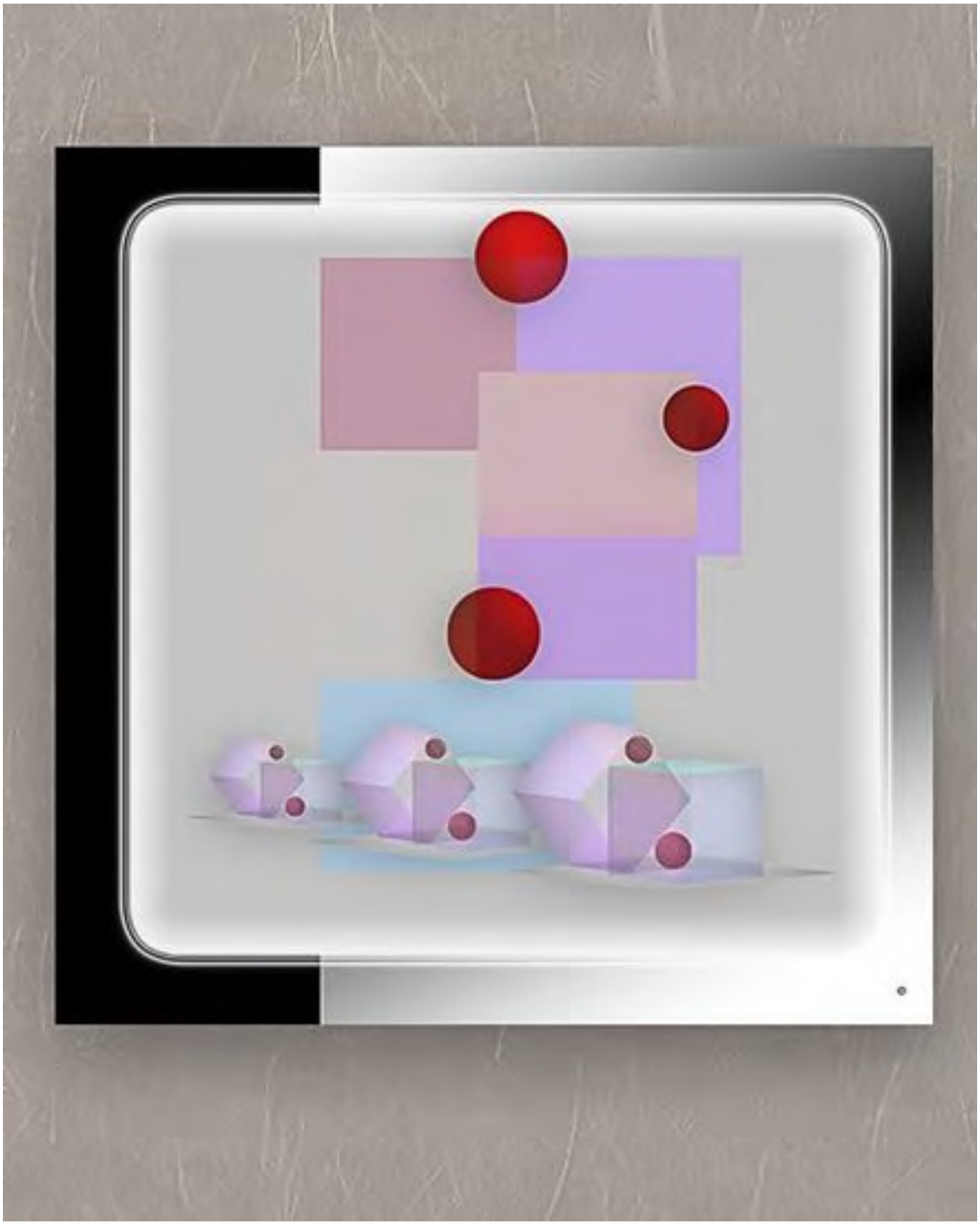

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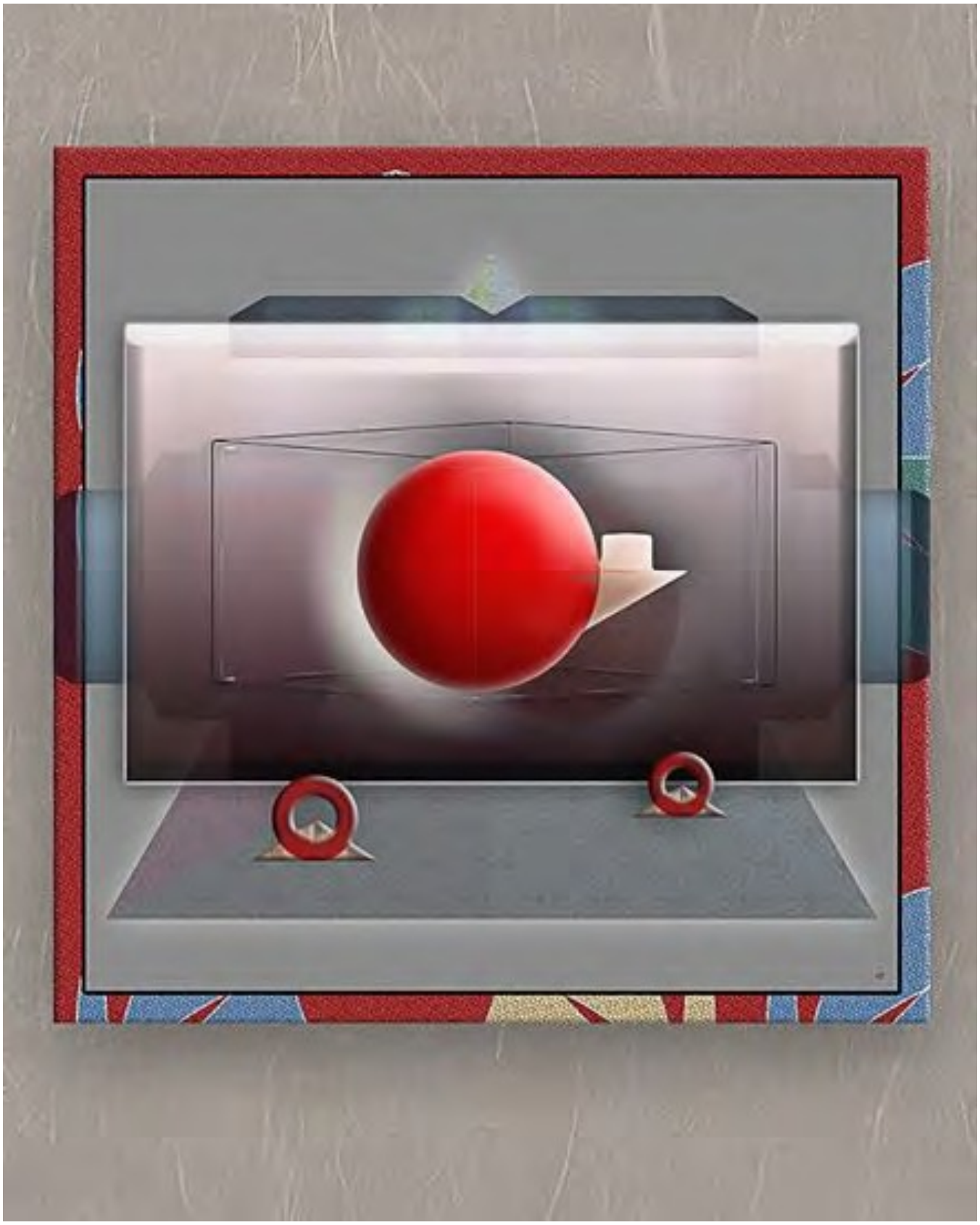

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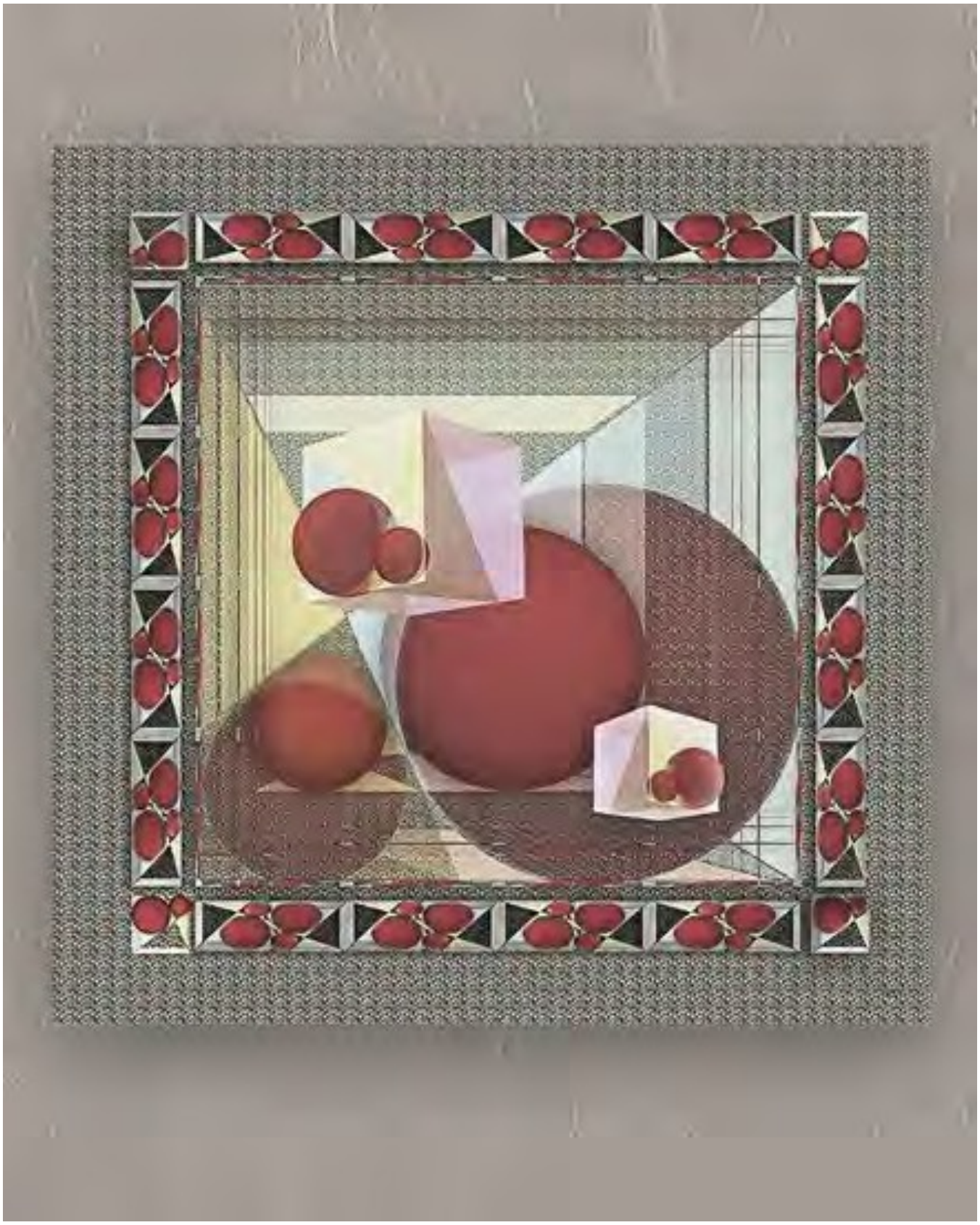

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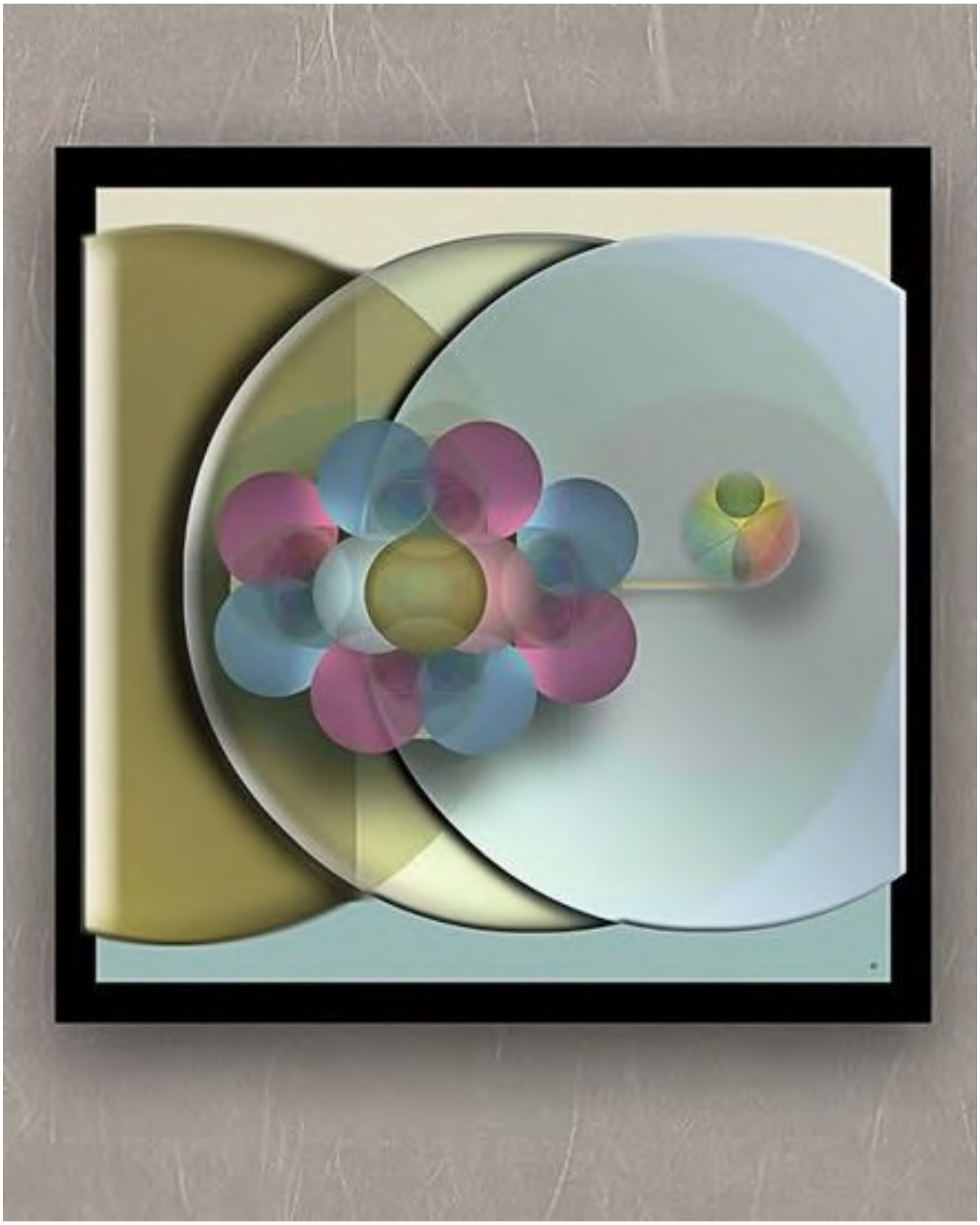

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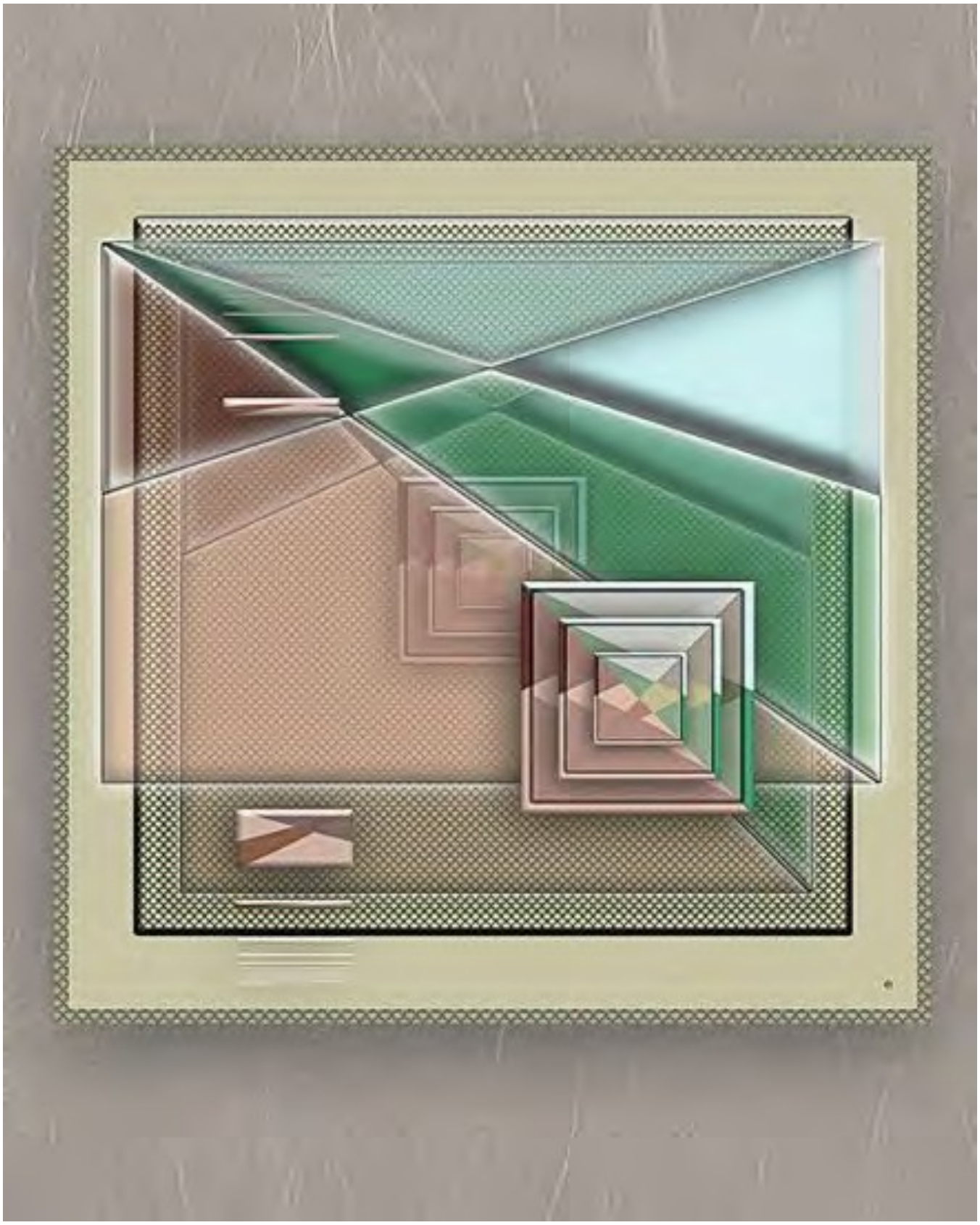

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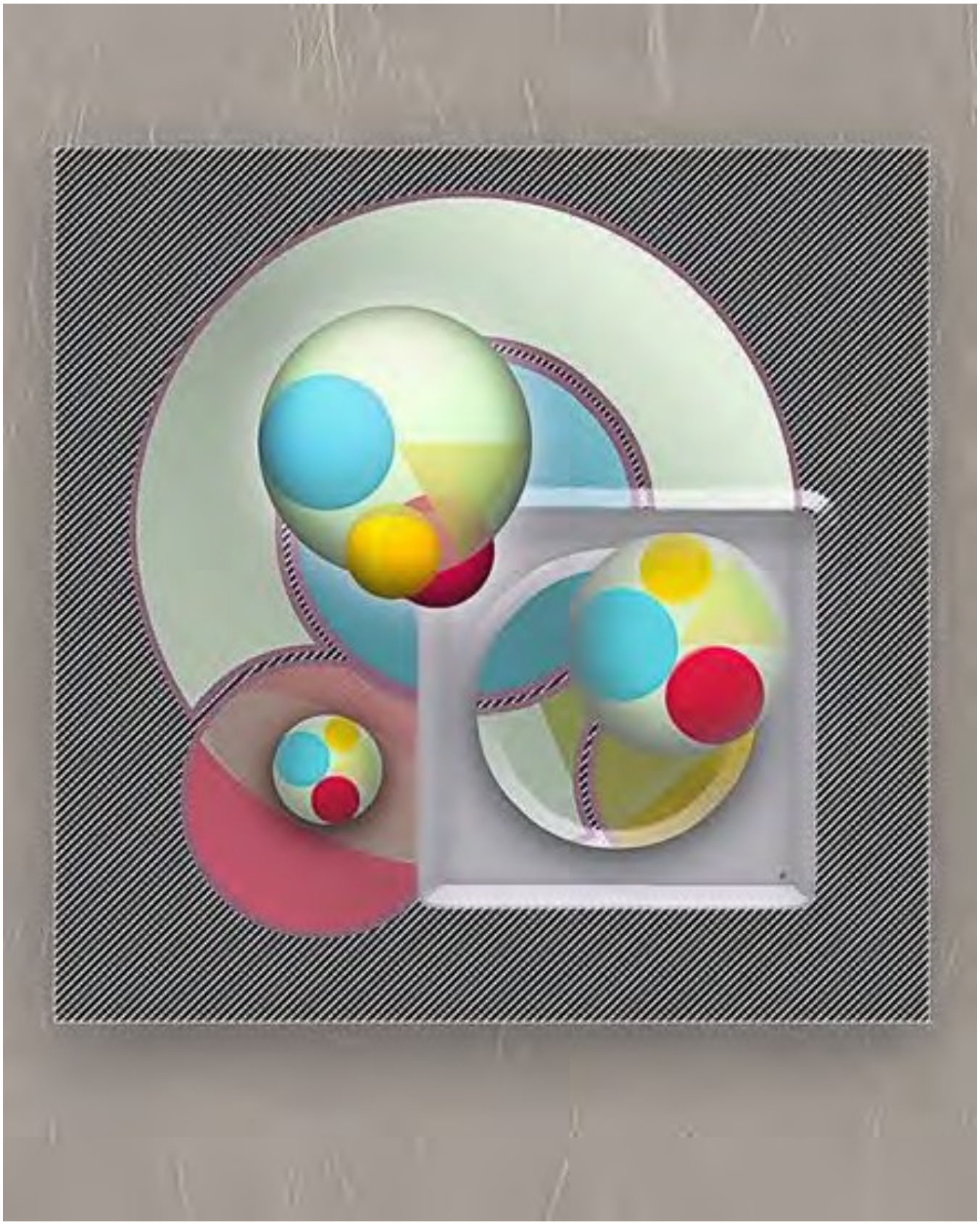

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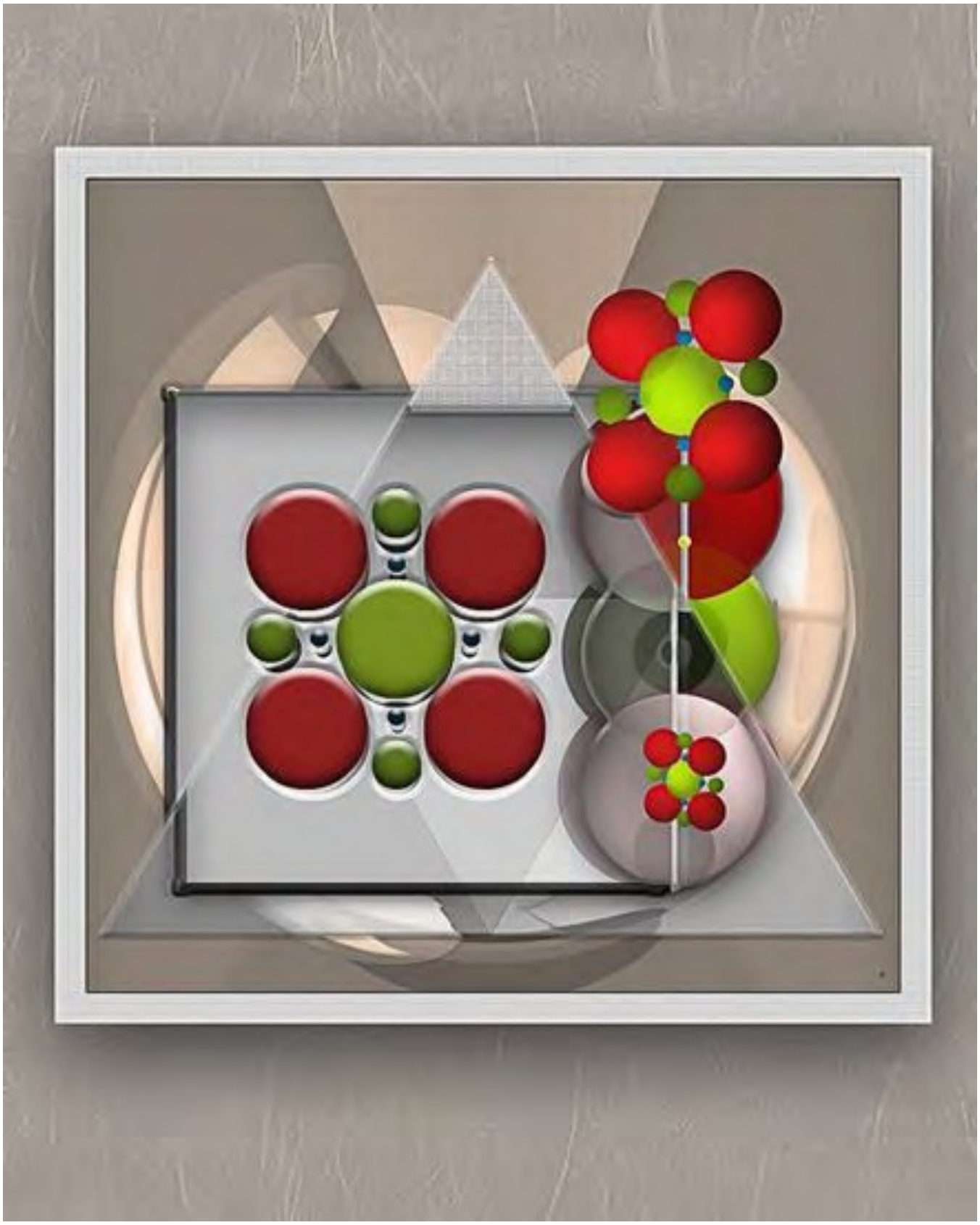

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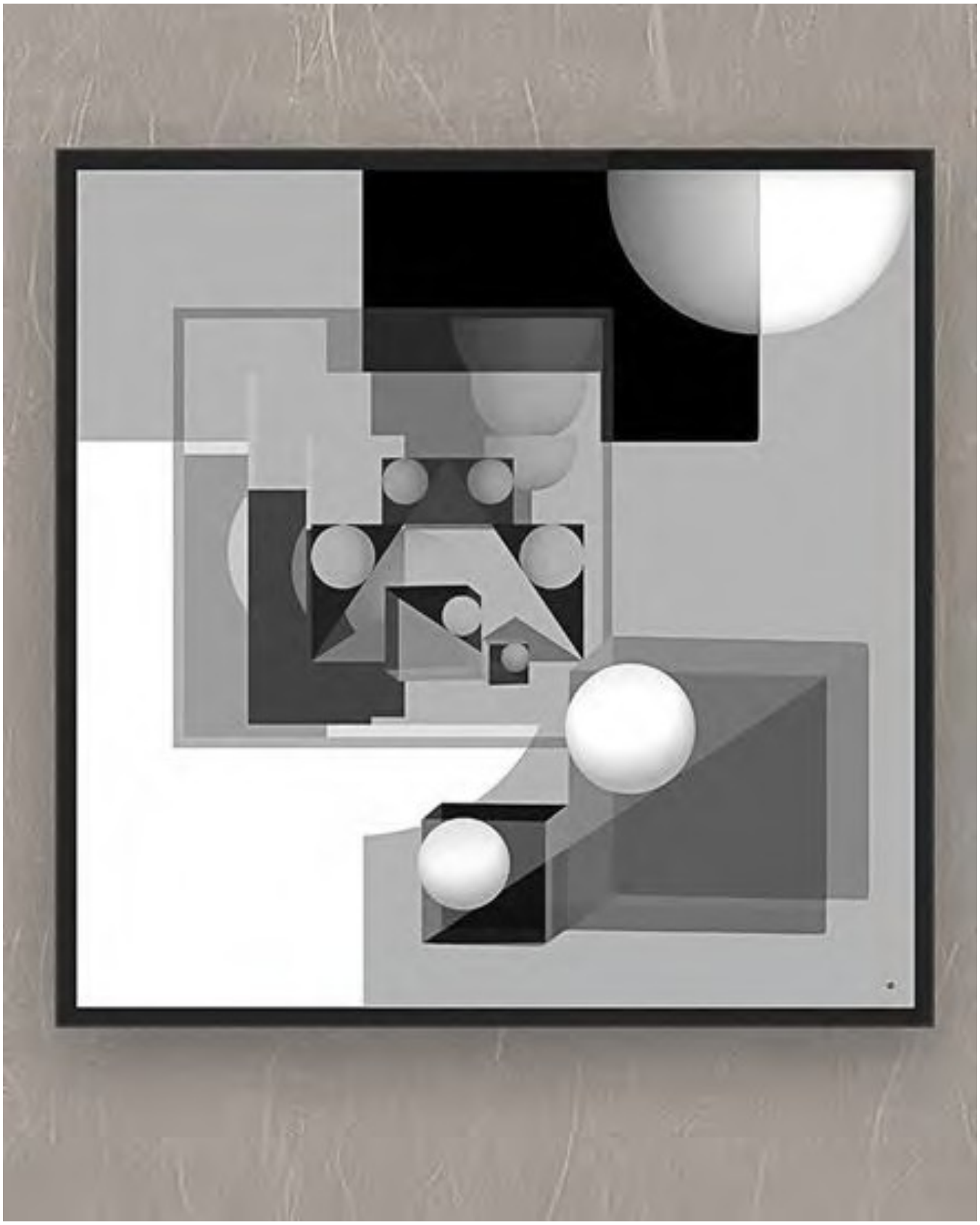

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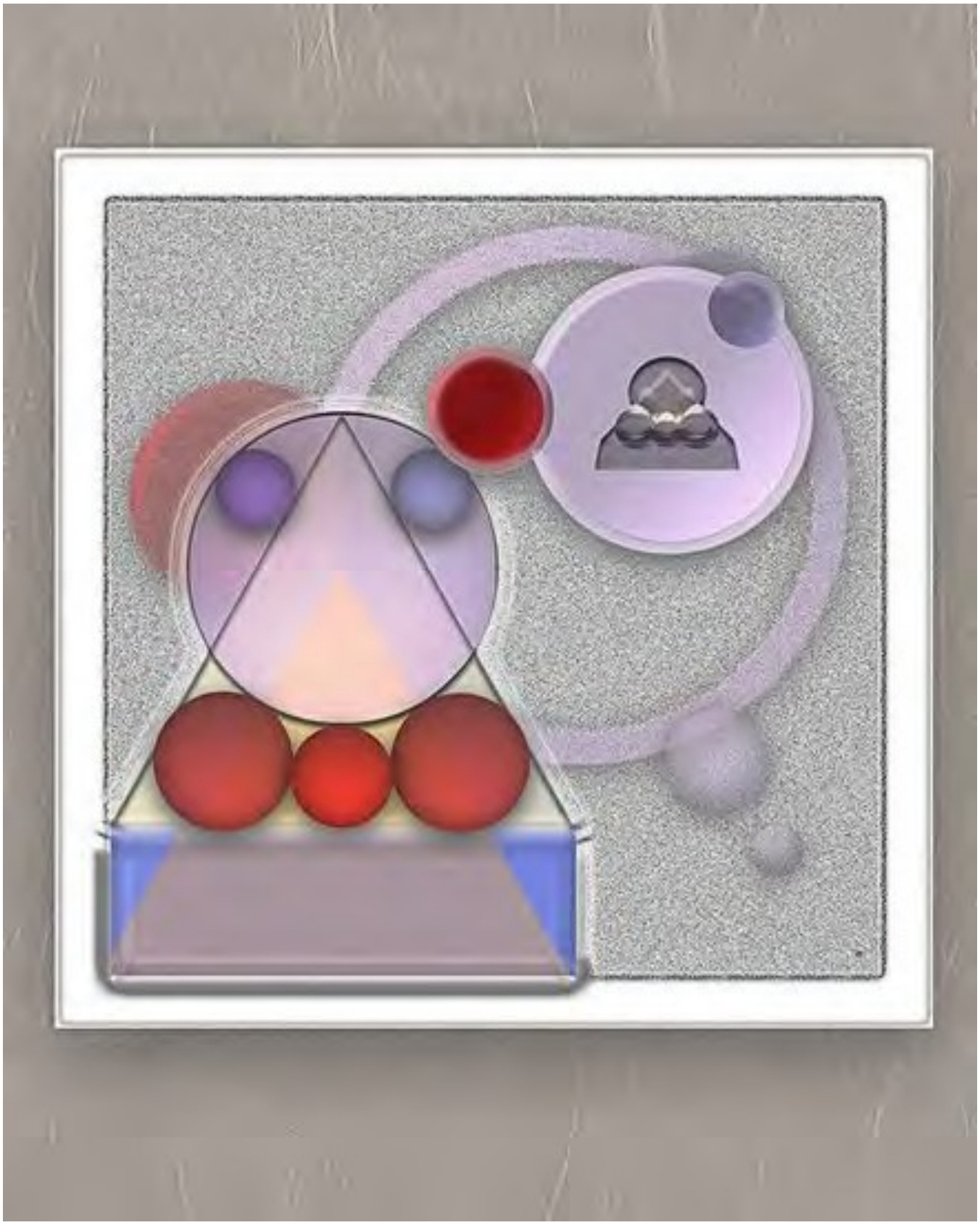

Figure #B-29

Figure #B-30

Figure #B-31

# Media

A media file animation, not included in this E.Book portfolio because of its size, is available on Vimeo and YouTube

https://vimeo.com/ , https://www.youtube.com/@bysance

# Resources

- **Gallery I. References**

**The outline and description match the figure numbers in Gallery I.*

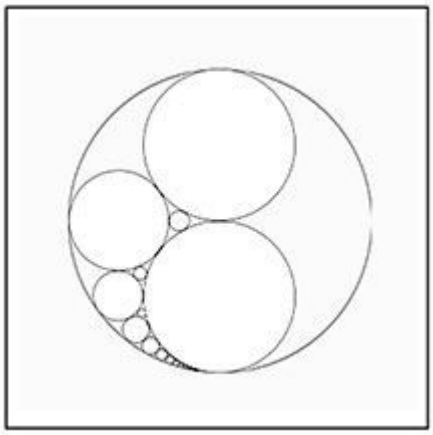

Figure #01

Tokyo Prefecture, 1788. Also called the Pappus chain. It asks for the radius of the nth largest inner circle in terms of r, the radius of the container circle. The original solution to this problem deploys the Japanese equivalent of the Descartes circle theorem.

Source: Harold P. Boas, Reflections on the Arbelos, American Mathematical Monthly 113, no. 3, pp 236–249, 2006.

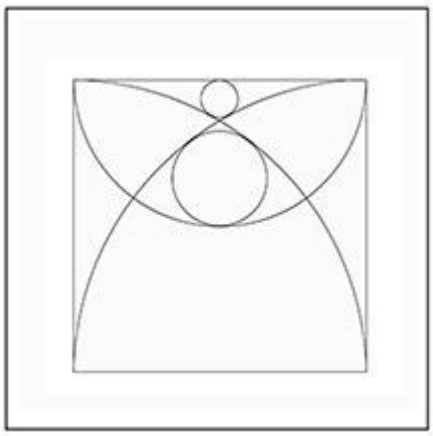

Figure #02

Aichi Prefecture, 1877. ABCD is a square of side a, and M is the centre of a circle with diameter AB; CA and DB are arcs of circles of radius a and centers D and C, respectively. Find the radius, r1, of the circle, centre O, inscribed in the area common to these circles. Find also the radius, r2, of the circle, centre O, which touches AB and touches CA and DB externally as shown.

Source: Jill Vincent & Claire Vincent, Japanese temple geometry, Australian Senior Mathematics Journal 18, 2004.

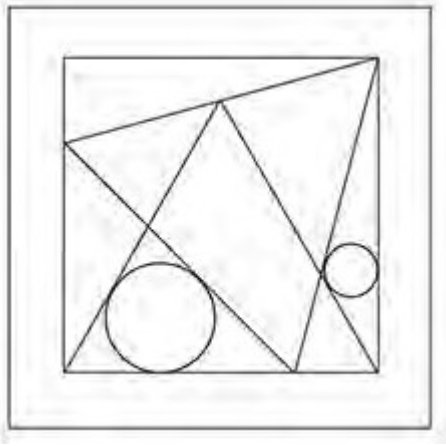

Figure #03

Miyagi Prefecture, 1877. Two equilateral triangles are inscribed into a square. Their sideline cut the square into a quadrilateral and a few triangles. Find a relationship between the radii of the two incircles.

Source: Jill Vincent & Claire Vincent, Japanese temple geometry, Australian Senior Mathematics Journal 18, 2004.

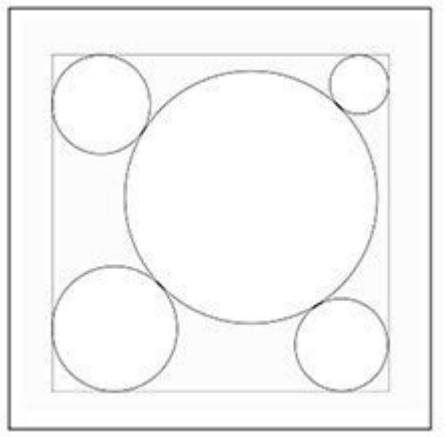

Figure #04

Tablet from the Gumma Prefecture, 1874. A large circle lies within a square. Four smaller circles, each with a different radius, touch the large circle as well as the adjacent sides of the square. What is the relation between the radii of the four small circles and the length of the side of the square? The problem can be solved by applying the Casey theorem, which describes the relation between four circles that are tangent to a fifth circle or to a straight line.

Source:  T. Rothman, H. Fukagawa, Japanese Temple Geometry, Scientific American, p. 87,

1998.

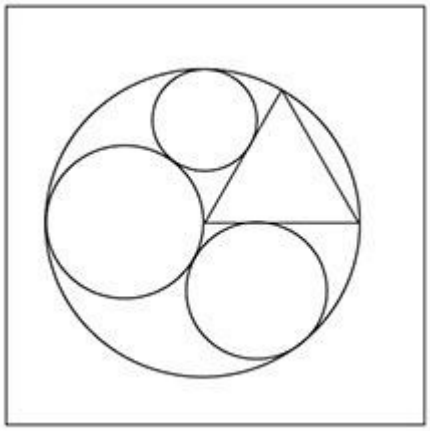

Figure #05

Gumma Prefecture, 1803. The base of an isosceles triangle sits on a diameter of the large circle. This diameter also bisects the circle on the left, which is inscribed so that it just touches the inside of the container circle and one of the triangle's vertices. The top circle is inscribed so that it touches the outer edges of both the left circle and the triangle, as well as the inner edge of the container circle. A line segment connects the center of the top circle to the intersection of the left circle and the triangle. Show that this line segment is perpendicular to the drawn diameter of the container circle.

Source: T. Rothman, H. Fukagawa, Japanese Temple Geometry, Scientific American, p. 87, 1998.

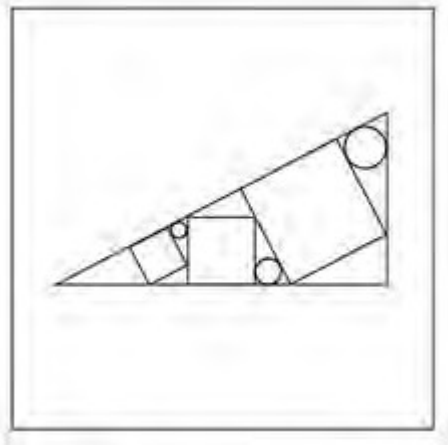

Figure #06

Miyagi Prefecture, 1913. Three orange squares are drawn as shown in the large, green right triangle. How are the radii of the three blue circles related?

Source: T. Rothman, H. Fukagawa, Japanese Temple Geometry, Scientific American, p. 86, 1998.

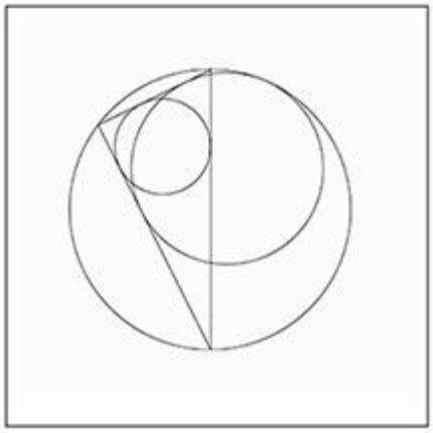

Figure #07

If CB'A is an isosceles triangle with CB' = CA, and B is a point lying on the line B'A, then one of the circles touching the circumcircle of BCB' internally and also touching AB and AC is twice the size of the incircle of ABC.

Source: H. Okumura and M. Watanabe, Tangent circles in the ratio 2: 1, Crux mathematicorum 27:2.116–120, 2001.

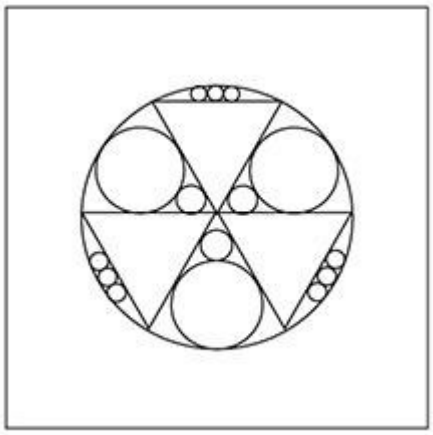

Figure #08

The figure is symmetric. AD, BE, and CF are the diameters of the circle O, and AOB = AOF = 60°. O1(a) and O4(b) touch each other externally, touch BE and CF, and O1 touches O internally. O7(c) touches O8(d) and O9(d) externally. O7, O8, and O9 touch AF and touch the circle O internally. Find d in terms of b.

Source: Eiichi Ito et al, Japanese Temple mathematical problems, Kyoikushokan Publishers, 2003.

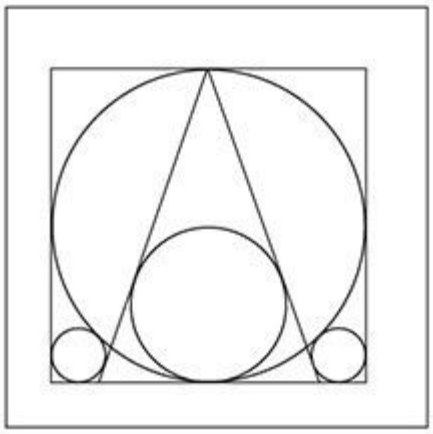

Figure #09

In a square PQRS, two circles are touching SP and the incircle of the square, where one of them touches PQ, and the other touches RS. Let A be the point of tangency of QR and the incircle, and let the tangents of the two small circles through A intersect the segment SP at B and C. Given the inradius of the square, find the inradius of the circle in the triangle ABC. The answer is that the medium circle is also half the size of the largest circle.

Source: H. Okumura, Japanese mathematics, Symmetry: Culture and Science, Vol. 12, Nos. 1-2, 79-86, 2001.

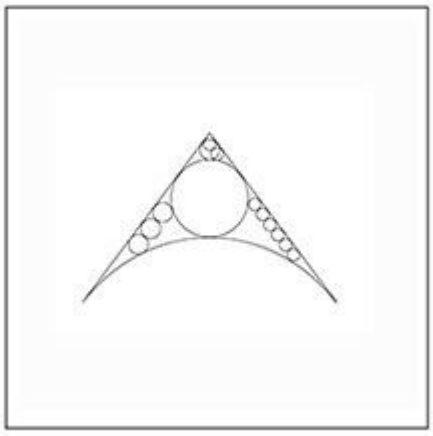

Figure #10

Three small congruent circles, two of which lie in the curvilinear triangles made by the two external tangents and the medium circle. The other lies in one of the curvilinear triangles made by the two larger circles and one of the external tangents. The ratio of the size of the two larger circles is 2:1. If there are two externally touching circles with different radii with external common tangents and if there are 4n congruent small circles, n of which lie in the curvilinear triangle made by the two external tangents and the medium circle, and 3n of which lie in one of the curvilinear triangles made by the two larger circles and one of

the external tangents, then the ratio of the size of the two larger circles is 4:1 for any natural number n - in this figure n = 1, 2.

Source: H. Okumura, Japanese Mathematics, special issue of Symmetry: Culture and Science, Symmetry in Ethnomathematics, 12(1-2), 79-86. 2001.

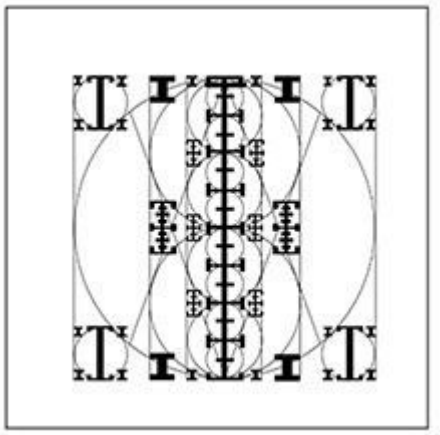

Figure #11

The ratio of the size of the two inscribed circles in the problem is 2:1. This provides an example of recursive computer programming.

Source: H. Okumura, Japanese Mathematics, special issue of Symmetry: Culture and Science, Symmetry in Ethnomathematics, 12(1-2), 79-86. 2001.

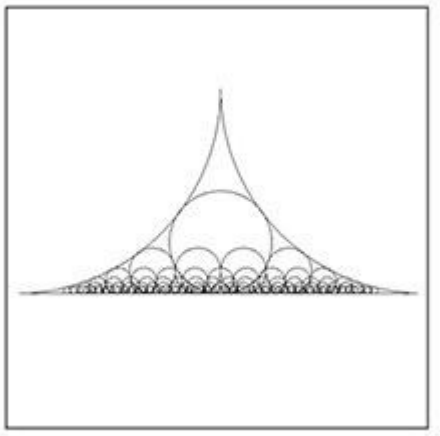

Figure #12

Congruent circles on a line. Problems involving several congruent circles on a line are considered, which yields several configurations of congruent circles on a line.

Source: H. Okumura, Configurations of congruent circles on a line, Sangaku Journal of Mathematics, Volume 1, pp. 24-34, 2017.

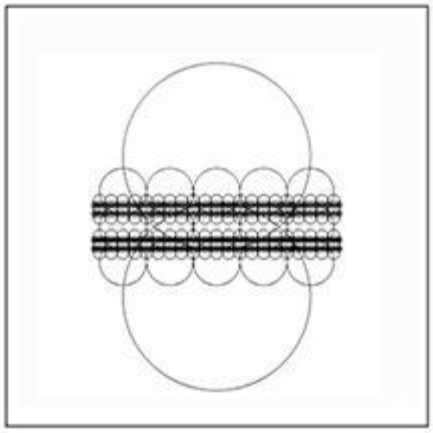

Figure #13

Congruent circles on a line. This problem relates to a 1809 Sangaku.

Source: H. Okumura, Configurations of congruent circles on a line, Sangaku Journal of Mathematics, Volume 1, pp. 24-34, 2017.

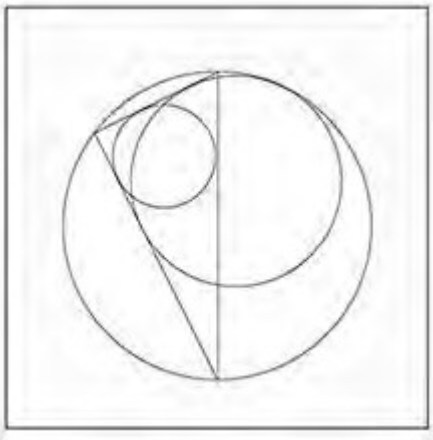

Figure #14

If CB'A is an isosceles triangle with CB' = CA, and B is a point lying on the line B'A, then one of the circles touching the circumcircle of BCB' internally and also touching AB and AC is twice the size of the incircle of ABC.

Source: H. Okumura and M. Watanabe, Tangent circles in the ratio 2: 1, Crux mathematicorum 27:2.116–120, 2001.

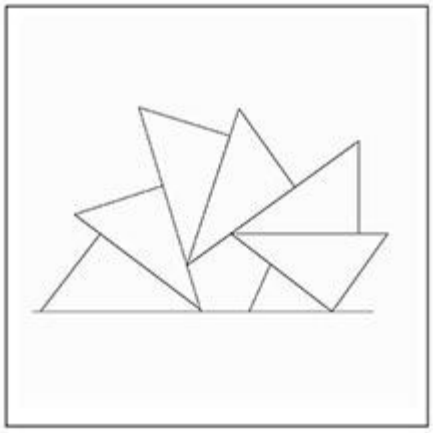

Figure #15

Miyagai prefecture, circa 1912. 6 congruent right triangles fan out along the sides of a regular pentagon of side a. Find the length of the hypotenuse t of these triangles in terms of a.

Source: Jill Vincent & Claire Vincent, Japanese temple geometry, Australian Senior Mathematics Journal 18, 2004.

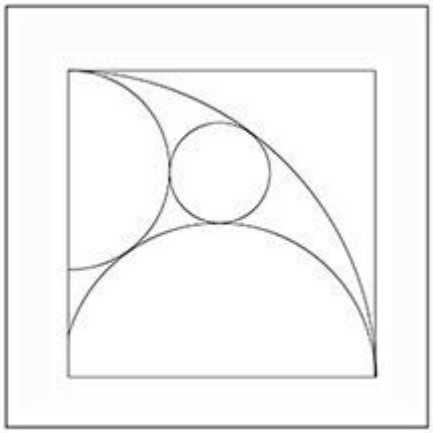

Figure #16

Find a relationship between the radius of the circle and the side of the square. The relative radii of the circles shown can be solved by an application of the Pythagorean theorem if 10, 11, 12 are combined into a single configuration.

Source: Alain Matthes, Tkz-euclide, CTAN archives, 2010.

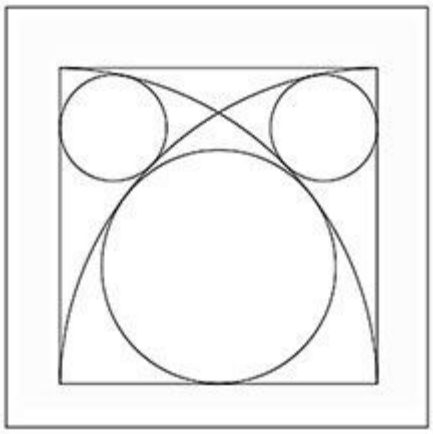

Figure #17

A square ABCD with a semicircle F on DC and its tangent AG extends to meet BC at H. All triangles will be 4, 5, 3 triangles. The full presentation is available on http://jstor.org.

Source: L. Bankoff, C. W. Trigg, The Ubiquitous 3:4:5 Triangle, Mathematics Magazine, Vol. 47, No. 2, pp. 61-70, 1974.

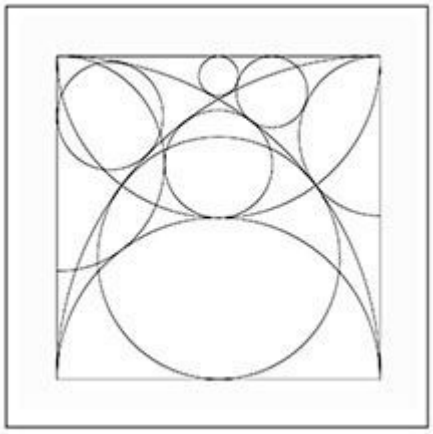

Figure #18

Present are quadrants, radius, and semi-circles.

Source: L. Bankoff, C. W. Trigg, The Ubiquitous 3:4:5 Triangle, Mathematics Magazine, Vol. 47, No. 2, pp. 61-70, 1974.

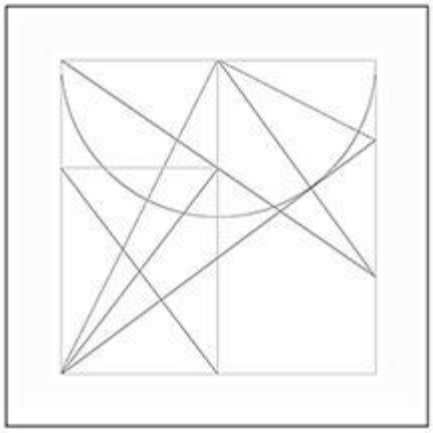

Figure #19

Extending the network of 3, 4, 5 triangles by drawing parallels inside the sides of those identified.

Source: L. Bankoff, C. W. Trigg, The Ubiquitous 3:4:5 Triangle, Mathematics Magazine, Vol. 47, No. 2, pp. 61-70, 1974.

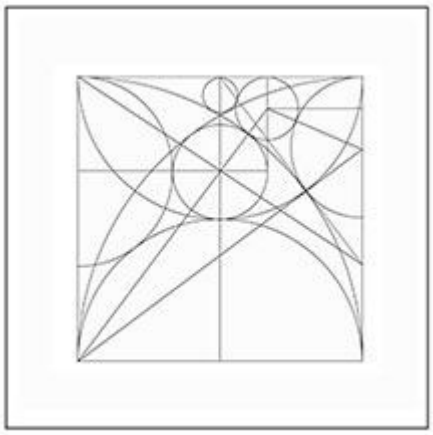

Figure #20

Source: L. Bankoff, C. W. Trigg, The Ubiquitous 3:4:5 Triangle, Mathematics Magazine, Vol. 47, No. 2, pp. 61-70, 1974.

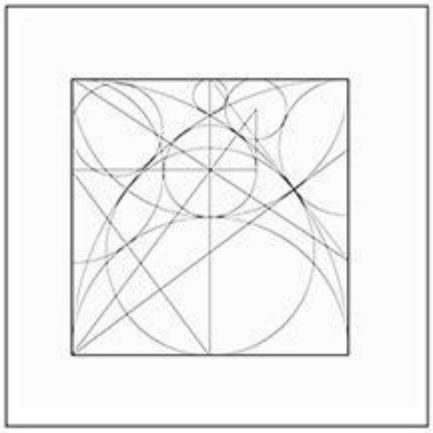

Figure #21

L. Bankoff, C. W. Trigg, The Ubiquitous 3:4:5 Triangle, Mathematics Magazine, Vol. 47, No. 2, pp. 61-70, 1974.

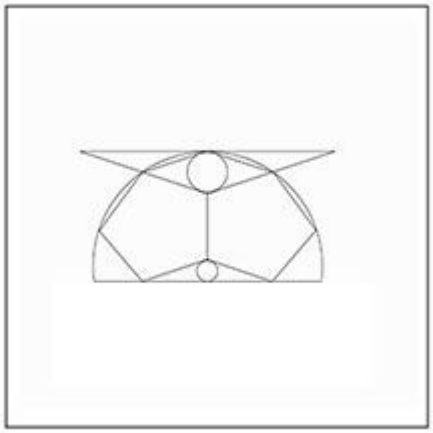

Figure #22

Two congruent regular pentagons with a side in common are inscribed in a large circle. A circle of radius r touches the large circle and the sides DE and EF of the pentagons, and the incircle of the triangle ABH has radius t. Show that r = 2t.

Source: H. Fukagawa, J. F. Rigby, Traditional Japanese Mathematics Problems of the 18th and 19th Centuries, SOT Publishing, Singapore, 2002.

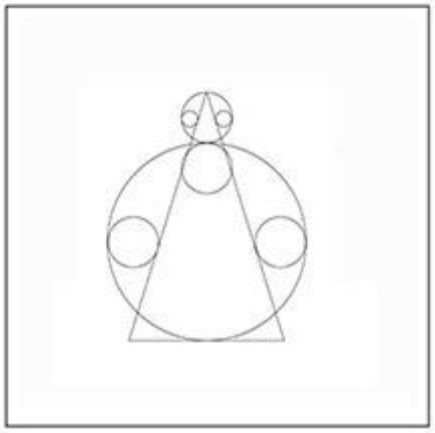

Figure #23

The making of a Sangaku.

Source: Kevin Petersen, Maths Department, Lynchburg College, VA.

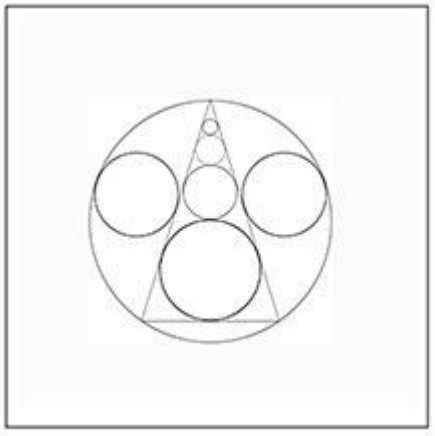

Figure #24

The making of a Sangaku.

Source: Kevin Petersen, Maths Department, Lynchburg College, VA

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- **Gallery II, References**

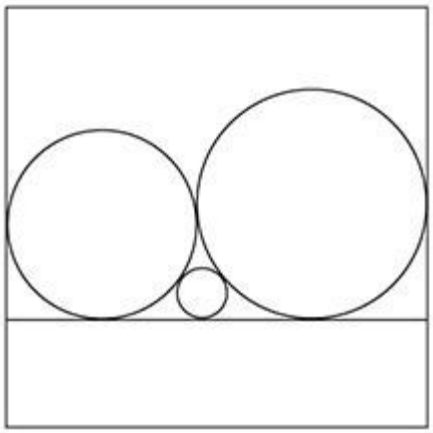

Figure #B-01

Miyagai prefecture, dated from 1892. Given three circles tangent to each other and to a straight line, find the radius of the middle circle via the radii of the other two.

Source:H. Fukagawa, Japanese Temple Geometry Problems, Charles Source: Babbage Research Ctr, 1989.

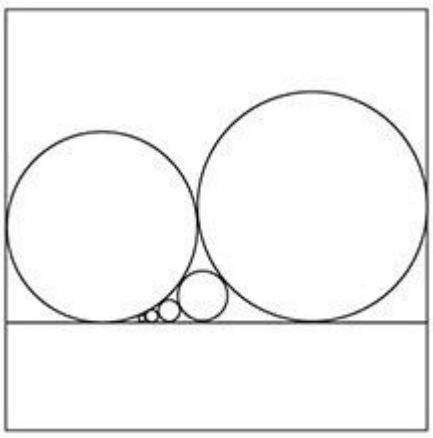

Figure #B-02

From a 1801 Sangaku found in the Osaka prefecture. On a flat surface, determine the radius of each circle (sphere) after the larger circle (sphere) and the square (cube) it tries to enter.

Source: H. Fukagawa, D. Pedoe, Japanese Temple Geometry Problems, Charles Babbage Research Ctr, 1989.

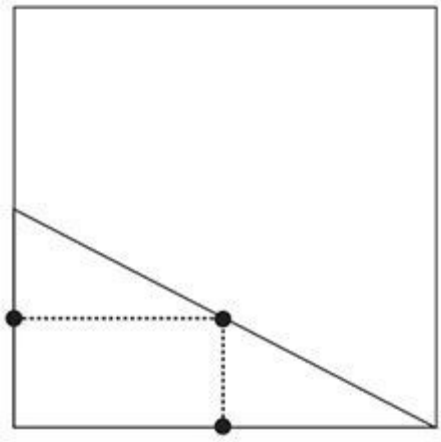

Figure #B-03

This 1806 Sangaku was originally written on a tablet hung in the Gikyosha shrine of Niikappugun, Hokkaido. Find the location of the point on the hypotenuse that maximizes the area of the rectangle. In 3-D, the shape takes the look of a temple or a pagoda. H. Fukagawa,

Source: T. Rothman, Japanese Temple Geometry, Princeton University Press, 2008.

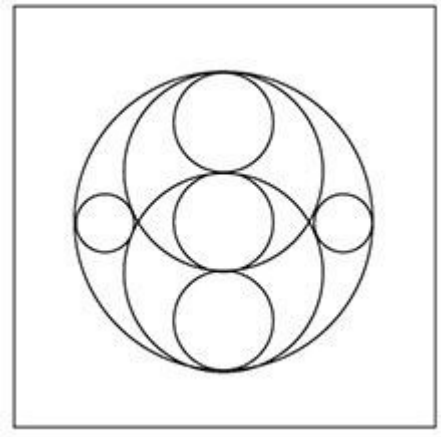

Figure #B-04

On a flat surface, six circles out of eight have obvious relations between their radii. Find the radius of the two small circles in terms of the radius of a bigger one. The background texture comes from a kimono design by Susan Weitzman-Conway.

Source:  Alex Bogomolny, Sangaku library, 1996-2018, http://www.cut-the-knot.org/pythagoras/Sangaku.shtml

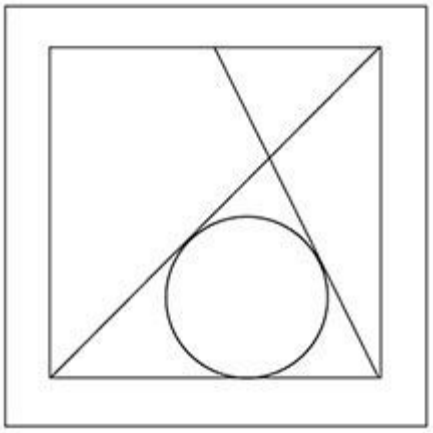

Figure #B-05

300-year-old Sangaku. Find the radius of the inscribed circle. In this 3-dimensional environment, once I found the circle's radius, it was tempting to free the sphere from the square and explore the space around the pyramid-like vertices.

Source: H. Fukagawa, D. Pedoe, Japanese Temple Geometry Problems, Charles Babbage Research Ctr, 1989.

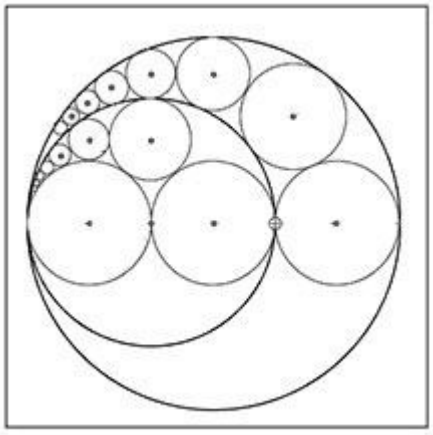

Figure #B-06

From an 1842 Sangaku found in the Nagano prefecture. It relates to the Pappus chain and the relationship between the circles and their chains. This is also a variation of the Golden Ratio in Five Steps as devised by Bùi Quang Tuån on Alex Bogomolny's site, Cut the Knot. https://www.cut-the-knot.org/do_you_know/BuiGoldenRatio5Step.shtml

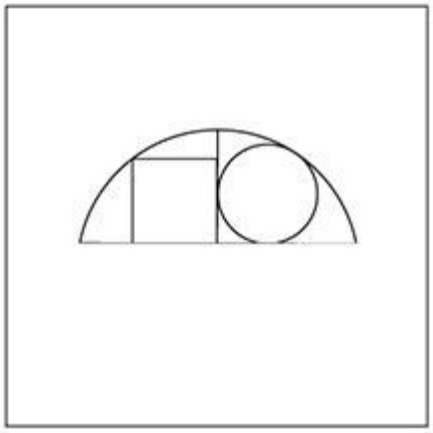

Figure #B-07

Mathematician Tsuda Nobuhisa proposed an answer to this problem in 1749 with a high-degree equation, one of one thousand and twenty-four degrees.

Source: H. Fukagawa, D. Pedoe, Japanese Temple Geometry Problems, Charles Babbage Research Ctr, 1989.

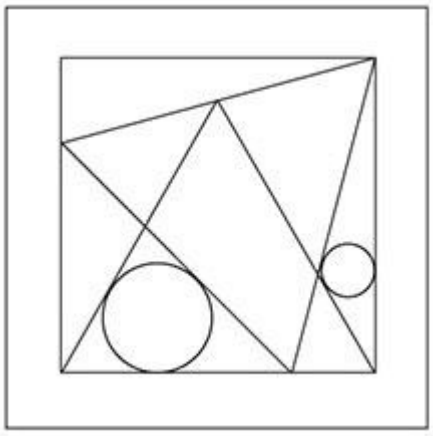

Figure #B-08

From the Miyagi Prefecture, 1877.Two equilateral triangles are inscribed into a square. Find a relationship between the radii of the two incircles. An alternate visualization of this problem is also available in Gallery I, problem #3.

Source: Jill Vincent & Claire Vincent, Japanese temple geometry, Australian Senior Mathematics Journal, v18 n1, p8-20, 2004.

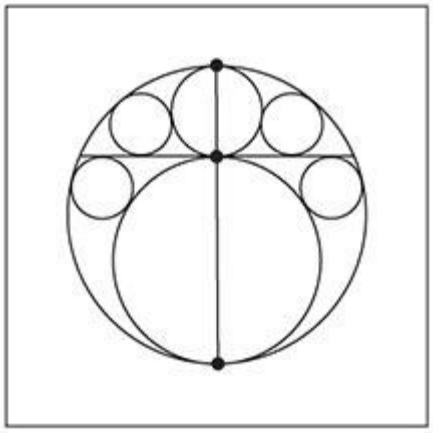

Figure #B-09

From a 1838 Sangaku tablet found in the Nagano prefecture. Shows r1 = r2 (the top two lateral circles). Archimedes meets Edo!

Source: H. Fukagawa, D. Pedoe, Japanese Temple Geometry Problems, Charles Babbage Research Ctr, 1989.

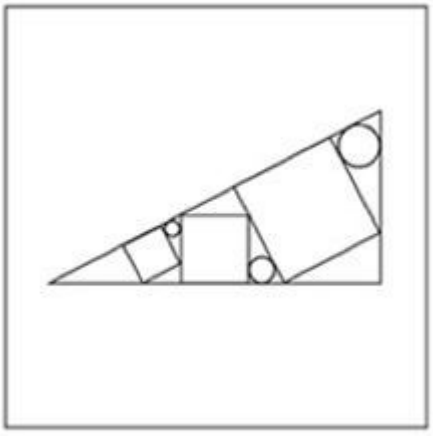

Figure #B-10

Sangaku found in Kiyomizu Temple, Kyoto Prefecture. Squares and circles are inscribed in successive right triangles. What is the relation between the radii of the circles? An alternate visualization of this problem is also available in Gallery I, problem #6.

Source: Ingmar Rubin, Tasks from the Japanese temple geometry, 2017. https://www.zum.de/Faecher/Materialien/rubin/sangaku.html

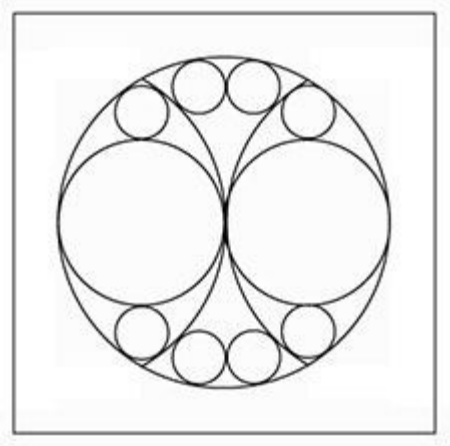

Figure #B-11

A 1865 Sangaku from the Meiseirinji temple in Ogaki City, Gifu prefecture. Show that the red circles equal the larger inner circles.
Source: Alex Bogomolny, Sangaku library, 1996-2018. http://www.cut-the-knot.org/pythagoras/Sangaku.shtml

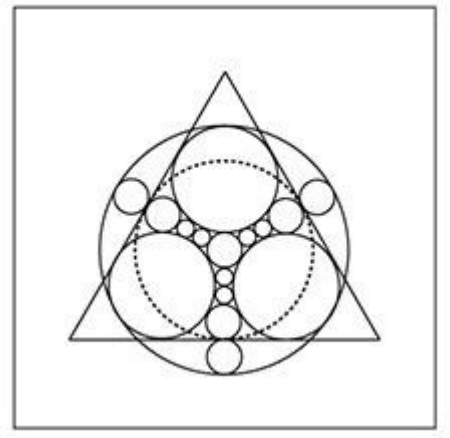

Figure #B-12

Tanabe Shigetoshi, age fifteen, created the original Sangaku in 1865 for the Meiseirinji temple in Ogaki City, Gifu Prefecture. It asks to find the radius of the smallest circles in terms of a virtual circle the size of the triangle, as shown by the red button on the left side. The image is a reconstruction of different 3-D perspectives of this problem.
Source: Alex Bogomolny, Sangaku library, 1996-2018. http://www.cut-the-knot.org/pythagoras/Sangaku.shtml

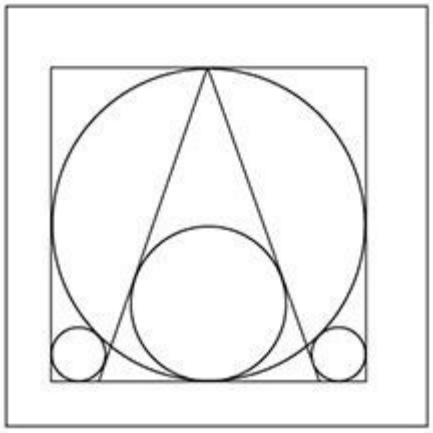

Figure #B-13

From the original 2-D descriptive: given the inradius of the square (cube), find the inradius of the circle (sphere) in the triangle (pyramid) – The answer is 1/2 the size of the largest circle. An alternate visualization of this problem is also available in Gallery I, problem #9.

Source: H. Okumura, Japanese mathematics, 2001, p. 81.

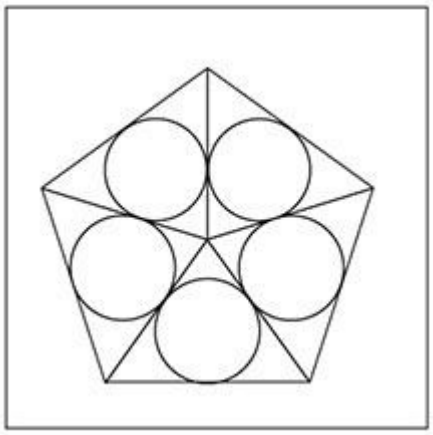

Figure #B-14

Knowing the size of the pentagon sides, find the diameter of each circle.

Source: H. Fukagawa, T. Rothman, Japanese Temple Geometry, Princeton University Press, 2008.

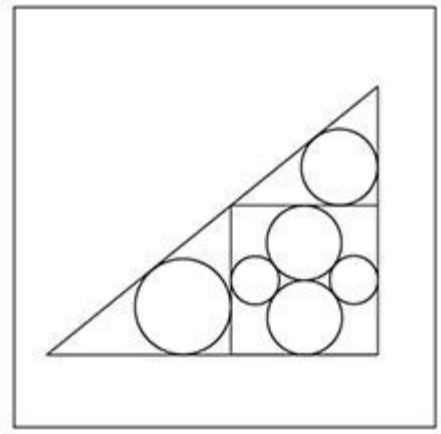

Figure #B-15

From a tablet dated 1847 found in the Akahagi Kannon temple in Ichinoseki city. Two circles of radius r and two of radius t are inscribed in a square. The square is inscribed in a large right triangle. Two circles of radii R and r are inscribed in the small right triangles outside the square. Show that R = 2t.

Source: Alex Bogomolny, Sangaku library, 1996-2018.

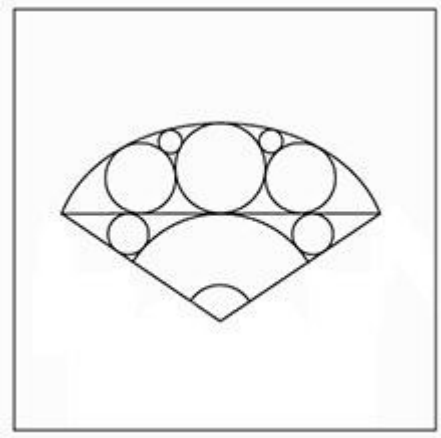

Figure #B-16

From the Isaniwa shrine in Ehime Prefecture (as recorded by Kinjiro Takasaka). The original problem can be found in the 7 spheres - lower right object.

Source: Kinjiro Takasaka, Sangaku Problem, Mathematikrätsel, 2004.

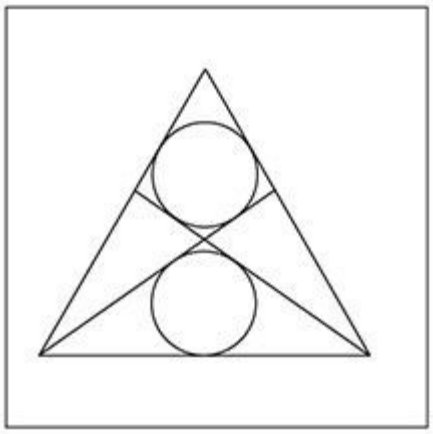

Figure #B-17

Katayamahiko shrine Sangaku, In an equilateral triangle ABC (center triangle in the image) of side 2a, two lines CE and BD touch two inscribed circles of radius r. Find r in terms of a.

Source: H. Fukagawa, T. Rothman, Japanese Temple Geometry, Princeton University Press, 2008.

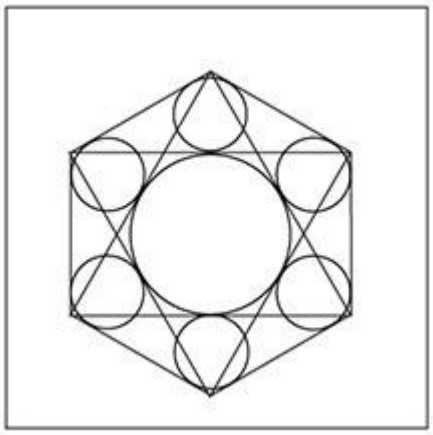

Figure #B-18

Another sangaku from the Katayamahiko shrine. It asks to find the size of the small circles in the hexagon in terms of the larger circle. The 3-D perspective turns it into an intriguing Pachinko -like trajectory game.

Source: H. Fukagawa, T. Rothman, Japanese Temple Geometry, Princeton University Press, 2008.

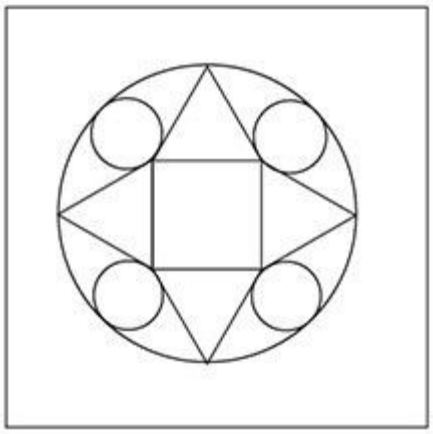

Figure #B-19

Sangaku problem from the Katayamahiko shrine. Four circles of radius r and four congruent equilateral triangles of side a touch a big circle of radius R internally and also touch a small square of side a. Find r in terms of R. Note: on the gallery visualization, the circles have been transformed in spheres, the triangles into pyramids and the square in a cube.

Source: H. Fukagawa, T. Rothman, Japanese Temple Geometry, Princeton University Press, 2008.

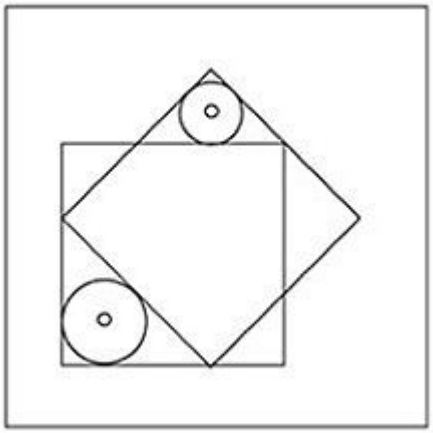

Figure #B-20

Find the size of the lower circle in terms of the upper circle. If this image had been drawn on a flat 2-D surface, we would find two equivalent squares, one tilted at 45º. The figure contains 2 circles in the inside surface where the squares overlap. Here, squares are cubes and circles - spheres.

Source: Eiichi, Nomura et al, Japanese temple mathematical problems in Nagano pref., Kyoikushokan publishers, 2003, p. 190.

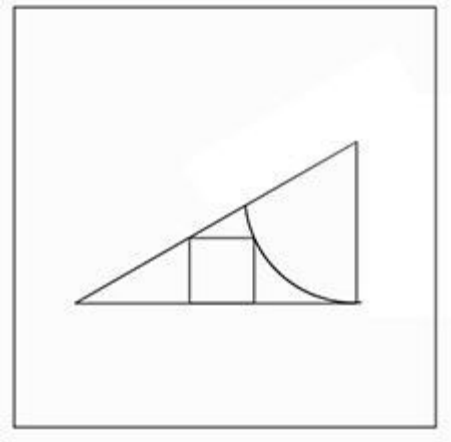

Figure #B-21

The two forward objects on the weaving describe the problem: a right triangle, a circular arc and a square between them. Find the sizes of each object in term of each other. The center composition is the same problem in 3-D saved in a translucent box.

Source: H. Fukagawa, T. Rothman, Japanese Temple Geometry, Princeton University Press, 2008. Press, 2008.

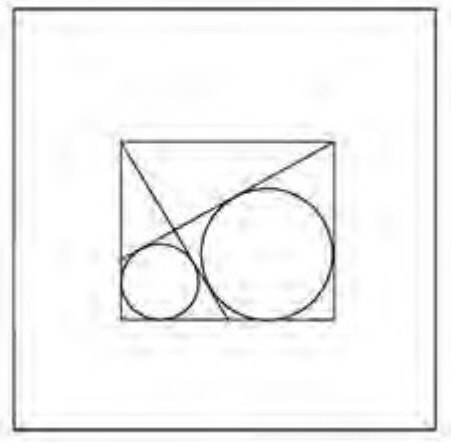

Figure #B-22

On the original tablet 2 circles were inscribed in a rectangle. Eiichi, Nomura et al, JJapanese temple mathematical problems in Nagano pref.,

Source: Kyoikushokan publishers, 2003, p. 156.

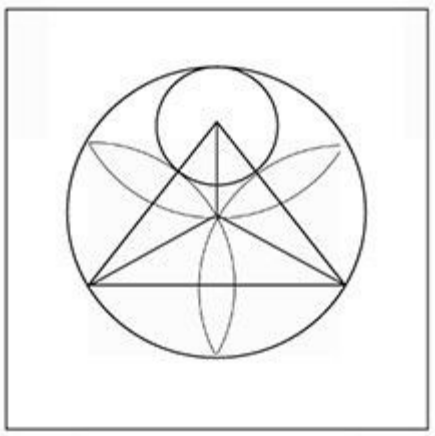

Figure #B-23

This Sangaku – encapsulated in the right side RGB sphere - asks: find the size of the small circle in terms of the 3 intersecting large arcs.

Source: Eiichi, Nomura et al, JJapanese temple mathematical problems in Nagano pref., Kyoikushokan publishers, 2003, p. 107.

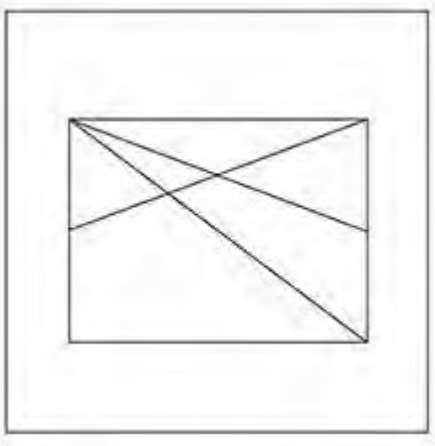

Figure #B-24

What is the size of the different segments making the upper left center triangle in the large rectangle?

Source: Eiichi, Nomura et al, JJapanese temple mathematical problems in Nagano pref., Kyoikushokan publishers, 2003, p. 285.

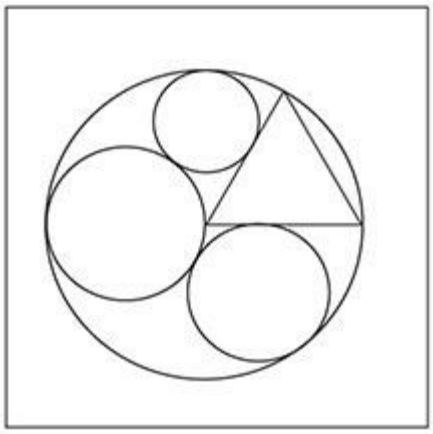

Figure #B-25

This sangaku asks to find the size of the circles in terms of each other. An alternate visualization of this problem is also available in Gallery I, problem #5.

Source: Eiichi, Nomura et al, JJapanese temple mathematical problems in Nagano pref., Kyoikushokan publishers, 2003, p. 10.

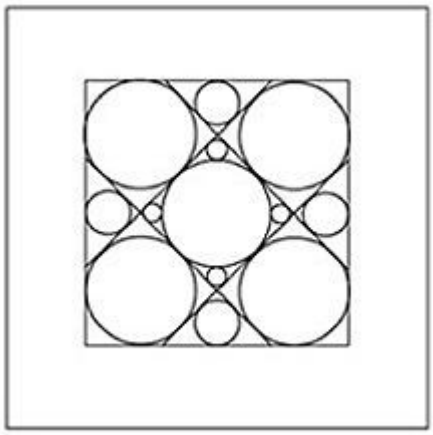

Figure #B-26

Find the size of the small green spheres in terms of the largest (red) minus smallest (blue) spheres.

Source: Eiichi, Nomura et al, JJapanese temple mathematical problems in Nagano pref., Kyoikushokan publishers, 2003, p. 287.

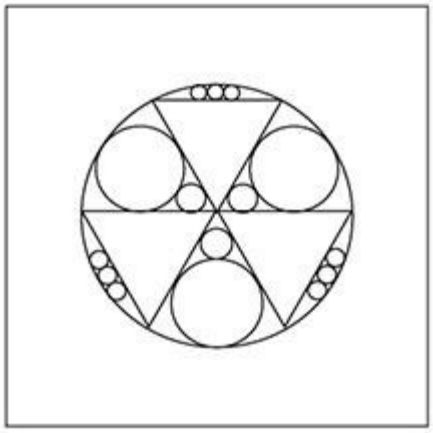

Figure #B-27

This Sangaku is intriguing because of the symmetrical aspect of its geometry. It asks to find the diameter of the smallest circle(s) in terms of the central circle(s).

Source: Eiichi, Nomura et al, JJapanese temple mathematical problems in Nagano pref., Kyoikushokan publishers, 2003, p. 264.

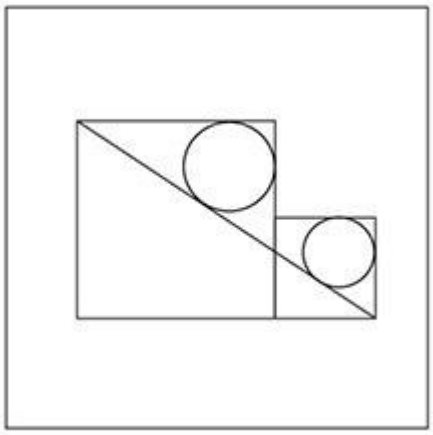

Figure #B-28

The original Sangaku tablet asked to find the size of the larger cube in terms of the two spheres as in the lower right part of the image.

Source: Eiichi, Nomura et al, Japanese temple mathematical problems in Nagano pref., Kyoikushokan publishers, 2003, p. 288.

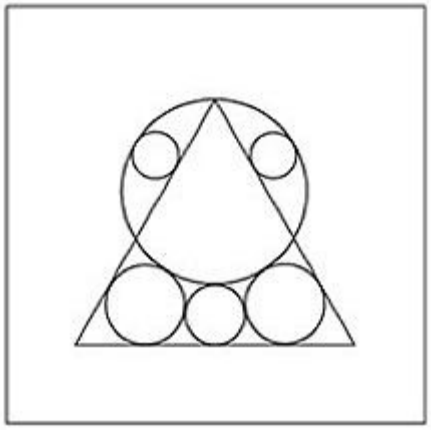

Figure #B-29

3 circles are in line. Find the size of the center circle in terms of the left and right circles.

Source: Eiichi, Nomura et al, Japanese temple mathematical problems in Nagano pref. Kyoikushokan publishers, 2003, p. 233.

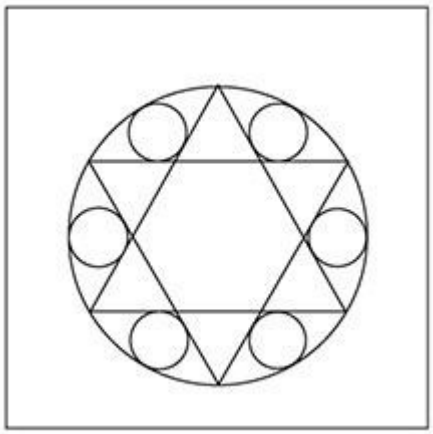

Figure #B-30

The tablet asks to find the radius of the small circles in terms of the sides of the triangles.

Source: H. Fukagawa, T. Rothman, Japanese Temple Geometry, Princeton University Press, 2008.

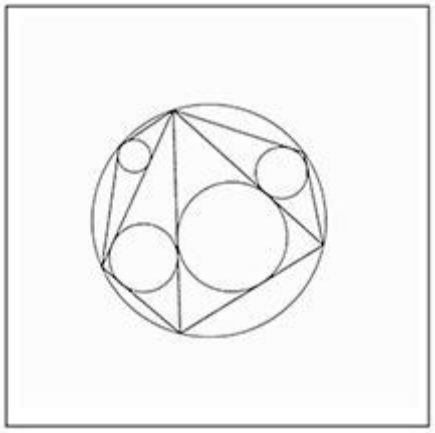

Figure #B-31

In geometry, the Japanese theorem states that, no matter how one triangulates a cyclic polygon, the sum of the inradii of the triangles is constant. Conversely, if the sum of inradii is independent of the triangulation, then the polygon is cyclic. This problem was sent to me by mathematician Dirk Huylebrouk. The problem description is available at http://mathworld.wolfram.com/JapaneseTheorem.html.

## Historical iconography

Following are some examples of Sangaku tablets from the 18th and 19th century, courtesy of Kyokushan Publishing. The original images along with the mathematical problems can be found in their 2003 book Japanese Temple Mathematical problems in Nagano Prefecture.

Miwa-Jinja Shrine Nagano City

Zenkoji Temple, Nagano City

Zenkoji Temple, Nagano City

Renkaian Temple, Nagano City

Renkaian Temple, Nagano City

Toride-jinja Shrine, Iiyama City

## General References


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## Glossary

***Casey theorem***

The Casey's theorem is a generalization of Ptolemy's. The latter deals with an inscribed quadrilateral.

Let a convex quadrilateral ABCD be inscribed in a circle. Then the sum of the products of the two pairs of opposite sides equals the product of its two diagonals. In other words, AD·BC + AB·CD = AC·BD

Source: http://www.cut-the-knot.org/Curriculum/Geometry/CaseyTheorem.shtml

***Circle***

A circle is all points in the same plane that lie at an equal distance from a center point.

The distance between the midpoint and the circle border is called the radius. A line segment that has endpoints on the circle and passes through the midpoint is called the diameter. The diameter is twice the size of the radius. A line segment that has its endpoints on the circular border but does not pass through the midpoint is called a chord.

Source: https://www.mathplanet.com/education/geometry/circles/basic-information-about-circles

***Congruent***

If one shape can become another using turns, flips and/or slides, then the shapes are congruent. After any of those transformations the shape still has the same size, area, angles and line lengths.

Source: https://www.mathsisfun.com/geometry/congruent.html

### *Descartes circle theorem*

In geometry, Descartes' theorem states that for every four mutually tangent circles, the radii of the circles satisfy a certain quadratic equation. By solving this equation, one can construct a fourth circle tangent to three given, mutually tangent circles. The theorem is named after René Descartes, who stated it in 1643.

Source: https://en.wikipedia.org/wiki/Descartes%27_theorem

### *Edo period*

The Tokugawa period, also called the Edo period (1603–1867), is the final period of traditional Japan, a time of internal peace, political stability, and economic growth under the shogunate (military dictatorship) founded by Tokugawa Ieyasu. The central authority of the Tokugawa shogunate lasted for more than 250 years.

Source: https://www.britannica.com/event/Tokugawa-period

### *Euclidean geometry*

Euclidean geometry is a well-known mathematical system attributed to the Greek mathematician Euclid of Alexandria. Euclid's text Elements was the first systematic discussion of geometry. The method consists of assuming a small set of intuitively appealing axioms and then proving many other propositions ( theorems) from those axioms. Although many of Euclid's results had been stated by earlier Greek mathematicians, Euclid was the first to show how these propositions could be fitted together into a comprehensive deductive and logical system.

Source: https://www.cs.mcgill.ca/

### *Isosceles triangle*

An isosceles triangle is a triangle with (at least) two equal sides. The name derives from the Greek iso (same) and skelos (leg).

A triangle with all sides equal is called an equilateral triangle, and a triangle with no sides equal is called a scalene triangle. An equilateral triangle is therefore a special case of an isosceles triangle having not just two, but all three sides and angles equal.

Source: http://mathworld.wolfram.com/IsoscelesTriangle.html

### *Kanbun*

Kanbun (lit. "Chinese writing") is a category of types of Japanese writing which employ

kanji (Chinese characters) exclusively, or almost exclusively, with minimal or no use of phonetic kana. The term most often refers to what might more specifically be called hakubun - Classical Chinese, or Japanese emulations of it, which incorporate no kana.

When written by Japanese scholars of Chinese subjects, such as Confucian scholars or Zen monks, Kanbun can sometimes include turns of phrase and individual characters more typically Chinese, which wasn't widely used in Japanese. However, the reverse is also true, as Japanese often wrote in a form closely emulating classical Chinese, but incorporating particular characters and turns of phrase original to Japan, which would be unfamiliar to a Chinese reader. Source: https://faculty.washington.edu

### *Pappus chain*

The Pappus Chain Theorem was discovered and proven by Pappus of Alexandria in the third century. In the 1800's, Jacob Steiner, a Swiss mathematician, found a simpler proof for the theorem which used the method of circle inversion.

In geometry, the Pappus chain is a ring of circles between two tangent circle obtained by drawing a circle stack between 2 lines. With geometric

inversion, the lines become the two major circles and the circles become the chain.

This result was known to Pappus, who referred to it as an ancient theorem (Hood 1961, Cadwell 1966, Gardner 1979, Bankoff 1981).

Source: https://archive.lib.msu.edu/crcmath/math/math/p/p039.htm

### *Radius*

A line segment extending from the center of a circle or sphere to the circumference or bounding surface.

### *Sangaku*

Sangaku are carved or painted tablets found in Shinto shrines and Buddhist temples in Japan and posing mathematical problems. The earliest Sangaku date a few years before the beginning of the Japanese Edo period (1603-1867) of self-imposed seclusion from the Western world.

Most of them were written in Kanbun, a little known language in everyday Japan. Record of some was made by mathematician Kazan Yamaguchi in the early 1800s. While the tradition almost entirely disappeared at the end of the shogunate, it is experiencing today a revival on the internet and in various papers shared by many worldwide.

Source: http://www.cut-the-knot.org/pythagoras/Sangaku.shtml

### *Square*

A square is a shape with four sides that are all the same length and four corners that are all right angles.

Source: https://www.collinsdictionary.com/dictionary/english/square

### *Tangent*

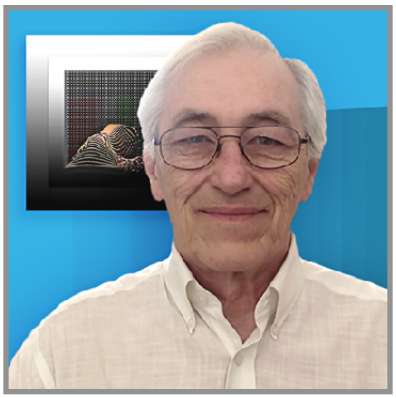
In geometry, the tangent line (or simply tangent) to a plane curve at a given point is the straight line that "just touches" the curve at that point. Leibniz defined it as the line through a pair of infinitely close points on the curve.

A convenient mnemonic for remembering the definition of the sine, cosine, and tangent is SOHCAHTOA (sine equals opposite over hypotenuse, cosine equals adjacent over hypotenuse, tangent equals opposite over adjacent).

The word "tangent" also has an important related meaning as a line or plane which touches a given curve or solid at a single point. These geometrical objects are then called a tangent line or tangent plane, respectively.

Source: http://mathworld.wolfram.com/Tangent.html

# About the Author



Jean Constant is an artist, researcher, and past professor of Visual Communication.

His interest in science and art led him to conduct extensive research in mathematics, science, and the visual arts, which he utilizes in the classroom and shares in lectures and exhibits in the US and worldwide.

He has published his research in numerous academic and professional journals and is the author of the ongoing Mathematics and Art series.

> *Art historians tell us art is either realistic or abstract. Because it's a journey of discovering Nature's existing structures, mathematics gives us a way to bridge the two forms of expression. Whenever I create a work inspired by mathematical concepts, I always end up with the intense feeling of representing just another aspect of our environment, a portrait, or a landscape that numerous artists depict so well. Nature, indeed, is made of many parts, seen and unseen.*
>
> *The contributions of scientists and engineers to our field of expression are to be recognized. The availability of digital technology in the palette of tools an artist can use today has significantly expanded the form and scope of my visualizations. It has uniquely deepened my interest in bringing to light some of the forms and circumstances surrounding us that the mathematical language mapped so beautifully in complex, abstract terms.*
>
> *Ultimately, whether on paper, a wall, a canvas, or today, on a screen, art is an exceptional journey of discovery and shared pleasure that I feel privileged to participate in and contribute to in a small way.*
>
> *J. Constant. Notes on "Geometry of Nature, part I".*

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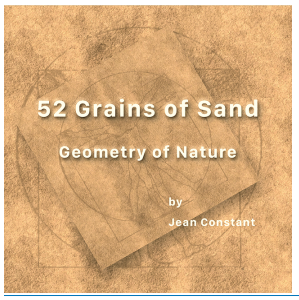

Nature Geometry

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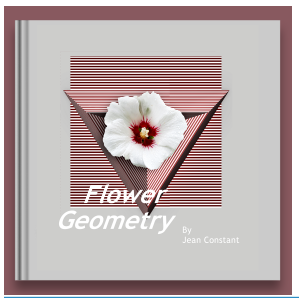

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The 12-30 Project

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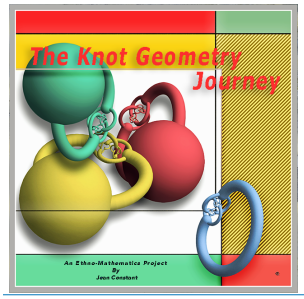
Digital Sangaku II



The Knot Geometry journey

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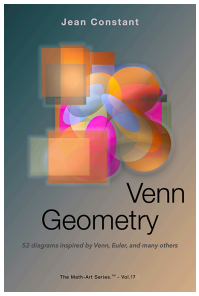

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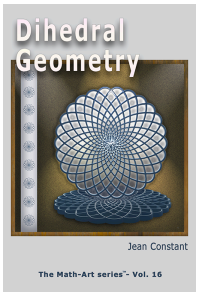

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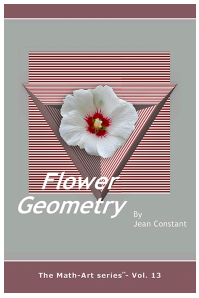
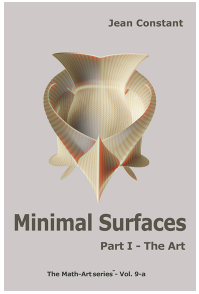
Prime Numbers.

Polyverse



Flower Geometry.

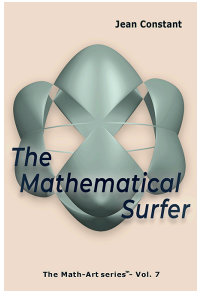
Stochastic Art



Minimal Surface-Art

Minimal Surface Geometry

The Quaste Quandary



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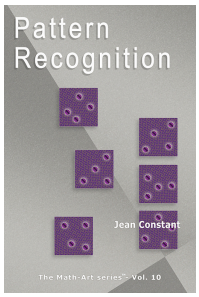
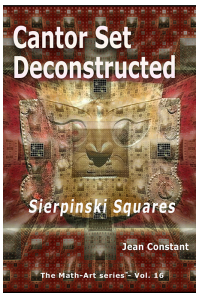
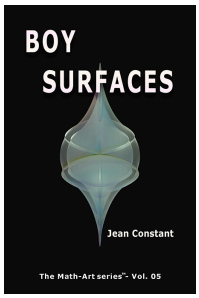


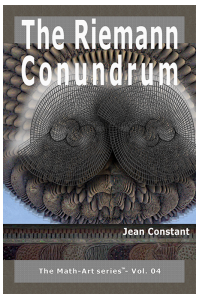

Pattern Recognition.



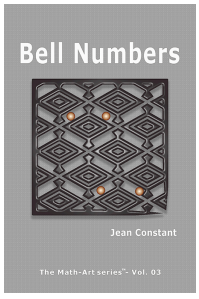

Cantor set deconstructed




Boy singular surfaces




Riemann’s conundrum

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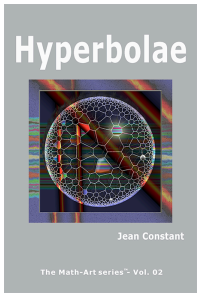
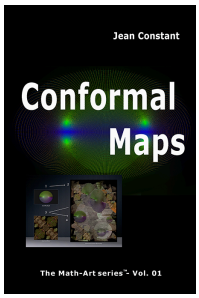
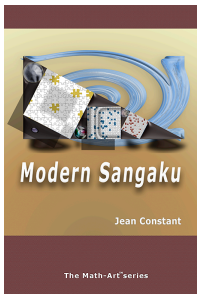


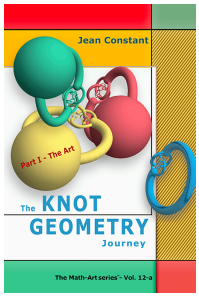

Hyperbolae




Conformal maps




Modern Sangaku

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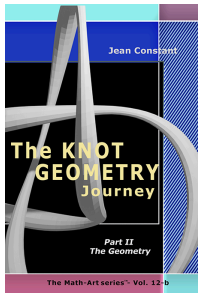


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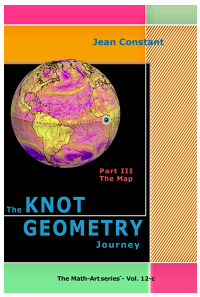

Knot Geometry. Part III

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